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On Communications

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On Communications

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Networking standards.

Nobody keeps your options open like Digital.

By now, everyone understands the need for standard communications protocols. Without them, an electronic Tower of Babel would surely ensue. But there have to be different standards for different networks. A local-area network is different from a wide-area network. A public network is different from a private one.

No single universal standard has emerged. Nor is one likely to. There are simply too many diverse networking environments, each fulfilling specific, mutually exclusive needs.

That's why Digital is committed to supporting and, in fact, actively promoting the more important standards now surfacing in the various environments.

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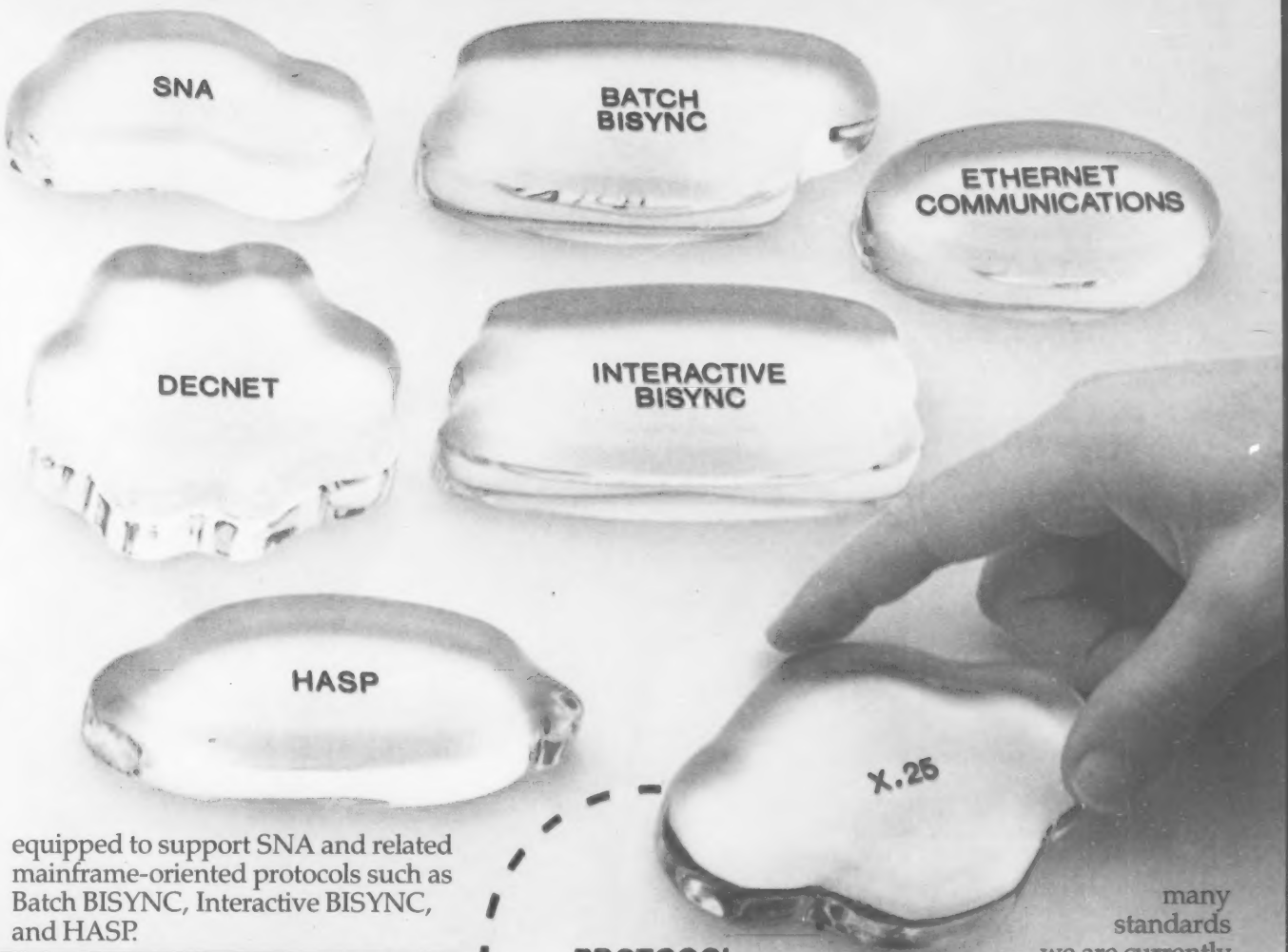
Hierarchical networks.

Even though we prefer to implement more flexible distributed networks, we are amply



equipped to support SNA and related mainframe-oriented protocols such as Batch BISYNC, Interactive BISYNC, and HASP.

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Digital is one of the original sponsors of the Ethernet™* specification that has been adopted by a number of computer, semiconductor, and office equipment manufacturers. We recognized early on the need for highly reliable local-area networks. We were in on the ground floor of the definition, development and, now, the implementation of the Ethernet specification.

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And so on.

We have listed a few of the many standards we are currently supporting. There are more. But even more important than the number of protocols is the attitude we have toward them. We are determined to help you meet any kind of networking objective. And our capabilities in that regard are as far-reaching as they are farsighted. So if you're planning a network, don't make the mistake of planning just for the present. Talk to the people who can meet your current needs and still keep your options open for the future. Talk to us.

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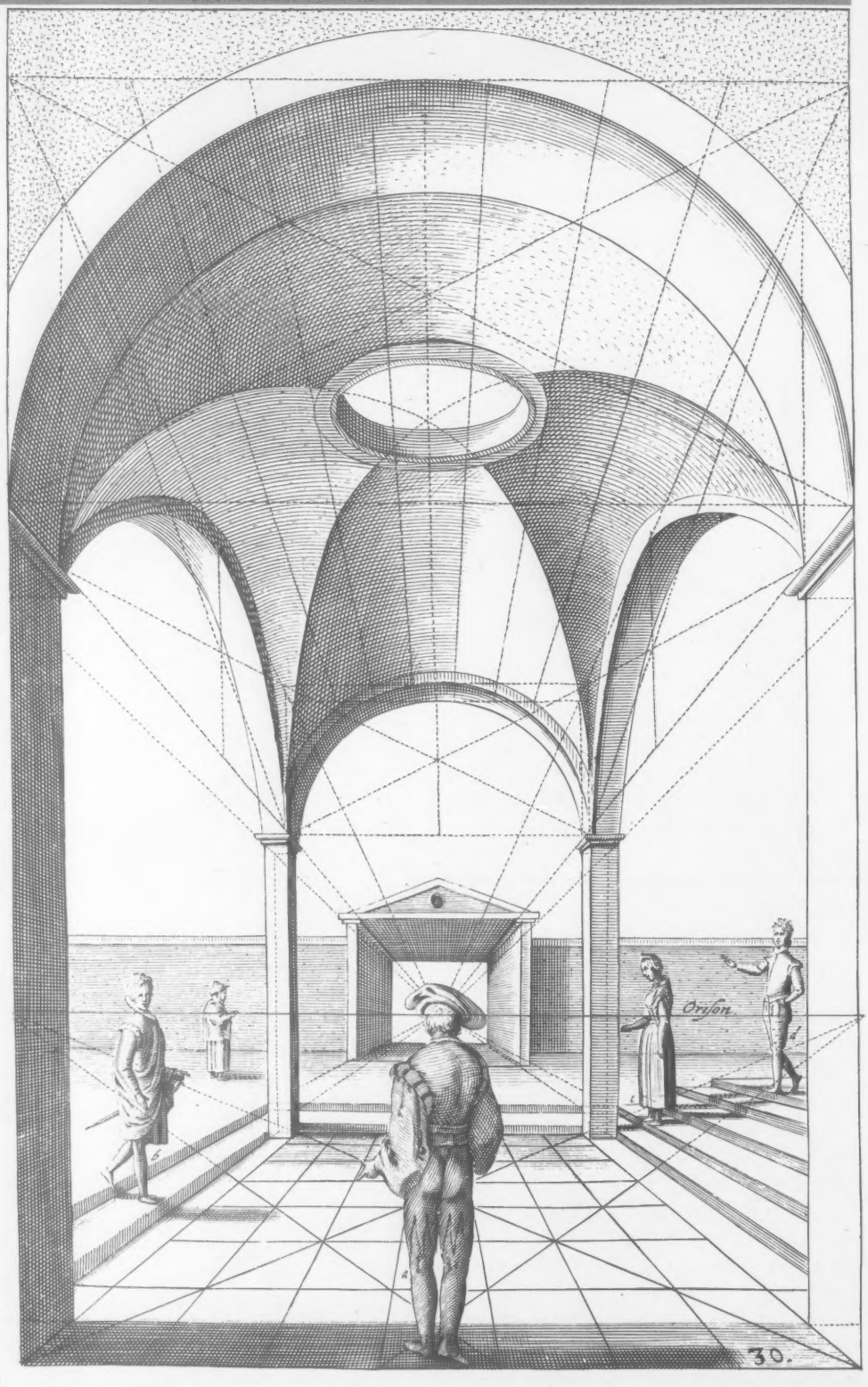
A Changing Perspective



A honeybee dances in midair; two ants stand face to face waving their antennae. Fires signal from hilltop to hilltop across the Grecian countryside.

A telephone rings in the middle of the night. A receiver in the Puerto Rico hills sits listening, waiting for a voice from beyond the solar system. A mainframe in Joliet, Ill., dials up a point-of-sale terminal in Topeka, Kan., and receives a full day's worth of sales and inventory data.

People and things go to great lengths just to communicate a few simple ideas. "What hath God wrought?" was Samuel Morse's first commercial telegraph message. Soon after, Alexander Graham Bell said, "Mr. Watson, come here. I want you." Yesterday's conversation between the mainframe in Joliet and the point-of-sale terminal in Topeka consists of bideep, beep, bideepbeep and lacks the drama of the previous messages, but the mainframe and the terminals communicate on a vastly different scale, a vastly different plane.

In this premiere issue and in succeeding ones, *Computerworld on Communications* will address voice and data communications and how to manage the problem of today's proliferation of communications methods and devices.

The idea that accurate communications can be planned permeates today's electronic culture. Unlike the days before the telegraph — when a select few made conscious and strenuous efforts to speed up delivery of only the most pressing messages and, even then, had little more on which to rely than their own feet — people today expect accurate, efficient communications services. People want information, and they want it fast.

The Federal Communications Commission acknowledged this prevailing need for effective transmission in its Second Computer Inquiry. The final decision in 1980 was designed to:

- Eliminate artificial boundaries between data processing and communications so that users can benefit from the merging of the two technologies.
- Minimize potential for cross-subsidy between regulated and unregulated services.
- Promote fair and equal competition.
- Protect the quality and efficiency of the national telephone services.
- Ensure open access to common carrier service.
- Foster an environment conducive to innovative offerings.

The challenge in communications today is to foster such an environment in which those innovative offerings can thrive. What are these offerings and what changes and landmark developments made them possible?

Communications no longer simply involves telephone and postal services: It encompasses much more. The U.S. telephone system is the biggest communications network in the world. Unfortunately, it is somewhat cranky when it comes to carrying data. Voice is no problem, but sending data over telephone lines is something else. It is slow, expensive and susceptible to corrupted messages. There must be a better way.

AT&T has completed laying its first fiber-optic links in the Northeast Corridor and is testing underwater optic cable as a preliminary to wiring the continents together.

Fifteen years after the Carterfone Decision allowed competition in the telephone market, there are independent long-dis-

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- Avant-Garde's product brochure, including Net/Switch and Tempo.

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EDITORIAL

tance carriers vying for the public dollar.

Microcomputers and local-area networks are allowing users to push the power of the computer out of the air-conditioned, security-bolted computer room onto the office floor and into the executive suite.

And as this initial access creates increased demand for more access and greater computing power, a host of problems arise. Incompatibility of hardware, software and design standards is forcing managers to make hard, expensive decisions — decisions that may be unnecessary in a very short time as the pace of technological change continues unabated.

Spend $6.2 million on a local-area network and six months later cry as another vendor announces a network product that has more bells and whistles than a circus parade. That is a hard decision to make — the kind that can lock you in a corner as the rest of the world goes by.

A powerful trend in data processing has emerged over the past few years. Computing power is beginning to flow out of the management information systems shop and onto the office floor. That same trend is evident in the communications field — cellular radio, national paging, vertical blanking interval message transmission over UHF television stations. A tremendous effort is being made to develop technology to reach individuals — not masses of people, but individuals, any place, any time.

But not just technological change will affect future data communications. Computing is becoming popularized. Food processors cost more than some microcomputers. The spread of the technology and the ethos of computing is picking up speed. Once there is a large popular base of computing, it is a different game altogether. And some people have an idea that a different approach will be needed — one that can handle the data processing needs of households, large and small company departments, managers and executives.

Integrated services digital networks (ISDN) — giant data processing communications networks accessible and usable by anyone with a telephone — seem to be headed our way. Firms like AT&T and IBM are mentioned in any discussion of ISDNs. The giant companies can afford to attempt to tie the country and the world together in one or two mammoth networks.

Imagine this scenario: Your financial vice-president sits in his office and punches numbers on his telephone keyboard and reads more numbers and words into the handset as the printer in the corner under the aspidistra starts to spit out hard copy. He could be talking to the computer room downstairs or he could be talking to a machine halfway around the world. Where that computer will be, no one knows. And it is a sure bet that our financial vice-president does not care. What he wants is no different from what anyone else wants — accurate, timely, cheap information. Where that information comes from is immaterial.

And our financial vice-president may not only have access to written data from a huge network thousands of miles away. He may also be able to take advantage of voice messaging — a logical step to digital storage and retransmission of voice once a telephone communications setup has been upgraded to handle data streams.

As data processing is pushed further and further into an office environment, the function is changed and adapted to its new surroundings.

No longer are most computers used to crunch gigantic number constructs, nor do they spend most of their time running repetitive programs in batch. Instead, the trend is toward interaction at an extremely local level, with electronic mail, voice messaging and spreadsheet analysis becoming more and more prevalent, more and more important parts of the total usage figure. And someday, listening capability may be available, further facilitating our vice-president's job, leaving him more time to address immediate problems as they arise.

Microcomputers are tying into mainframes, whose role is becoming weighted toward merely maintaining immense data bases of information and programs and driving pervasive communications networks. The information utility is on the horizon, existing merely to facilitate micros' use of that data base.

But when it comes right down to it, the most important event in this decade for both data processing and communications was the unleashing into the free market of the two largest companies in the business. With their manacles loosened, both AT&T and IBM

OH WHAT A YOU WEAVE.

have entered new territories. IBM has entered the remote processing business, and AT&T has entered the computer field. Through American Bell, the world's largest communications entity is selling its own computers and data terminals. Is there a genuine ISDN lurking nearby in the future?

It doesn't do much good to have a computer full of data but not be able to move that information quickly and easily. You can print it out, but that can be a messy waste of expensive paper. The first step is to put terminals in the office and the executive suite. The next is to put terminals anywhere there is a telephone. We have begun to take the first step, and there are signs that the second step is not too far away. Once the symbiosis between data processing and communications is well established, the concept of ISDNs becomes imminently respectable. The only stumbling block would be in the early stages of implementation.

The history of communications is a long road full of dead ends. For example, the essential elements and concepts necessary for the development of the telephone were discovered in 1831 by Michael Faraday, but it took 40 years for an innovator to apply them: Alexander Graham Bell did not patent his harmonic telegraph until 1876. People were not ready to accept innovation — thus, the delay. We must support, even encourage, research and development, be willing to test innovations, keep an open mind.

Charting a path into the future will take a concentrated effort, to which each of us can contribute by giving our support. The technology itself will help. With each advance, with each new product, the ties between data processing and communications, the twisted pairs of benefits and dependencies, will tighten. Each new product will add to the definition of communications, help to define the goals and chart the path to those goals.

Regardless of the pace of technological development, it will inevitably be accompanied by a proliferation of legal and regulatory confusion. But this confusion does not necessarily have to be detrimental. For those willing to keep informed, willing to take a chance on temporary service vendors, opportunities abound. The important thing is to remain confident in the midst of confusion and to make the best of what is available, always expecting new alternatives to emerge. Not an easy task, but those that can accomplish it will surely reap the benefits of their perseverance.

All the above-mentioned innovations — ISDNs, cellular radio, UHF transmission — concern the transmission of data. But mere data is not enough. It must be managed. Despite indications that communications are improving and costs are decreasing, today's economy is still shaky.

Nothing can be taken for granted. DP managers and individuals must constantly look ahead, must choose wisely from the myriad of alternatives available with an eye toward both efficiency and cost-effectiveness. With proper planning, the right communications method can be chosen — from a single telephone line to an integrated system.

Plan, but also beware of excess planning. In today's world, timeliness is vital. Make decisions wisely, but make them quickly.

No, data is not enough: Data is not information. It is an entity from which information can be extracted, and it must be assimilated and processed by a human being in order to be useful as information. Mere blips on a screen, facts and figures stored on a disk, mean nothing until applied effectively by a person. The first marathon runner's message to the Athenians, "Rejoice, we conquer," would have meant nothing if delivered to an empty forum. The people make the message count, not the data alone.

Once acquired, information extracted from transmitted data is not an end in itself. It must be assimilated, applied, distributed and delivered. The race must continue. It is our duty to continue the communications revolution, to run hand in hand with emerging technology, to help each wave give way to the next, creating an ever-increasing continuum of data transformed into information, and with that information, reshape the world.

Computerworld on Communications will try to clarify and interpret the issues and questions we will all face today and in the future regarding the impact the communications revolution will have on our work and on our lives. We want this to be a dialogue. Communicate with us. Let us know what's on your mind and agenda regarding communications. We will try to help you find the answers. ■

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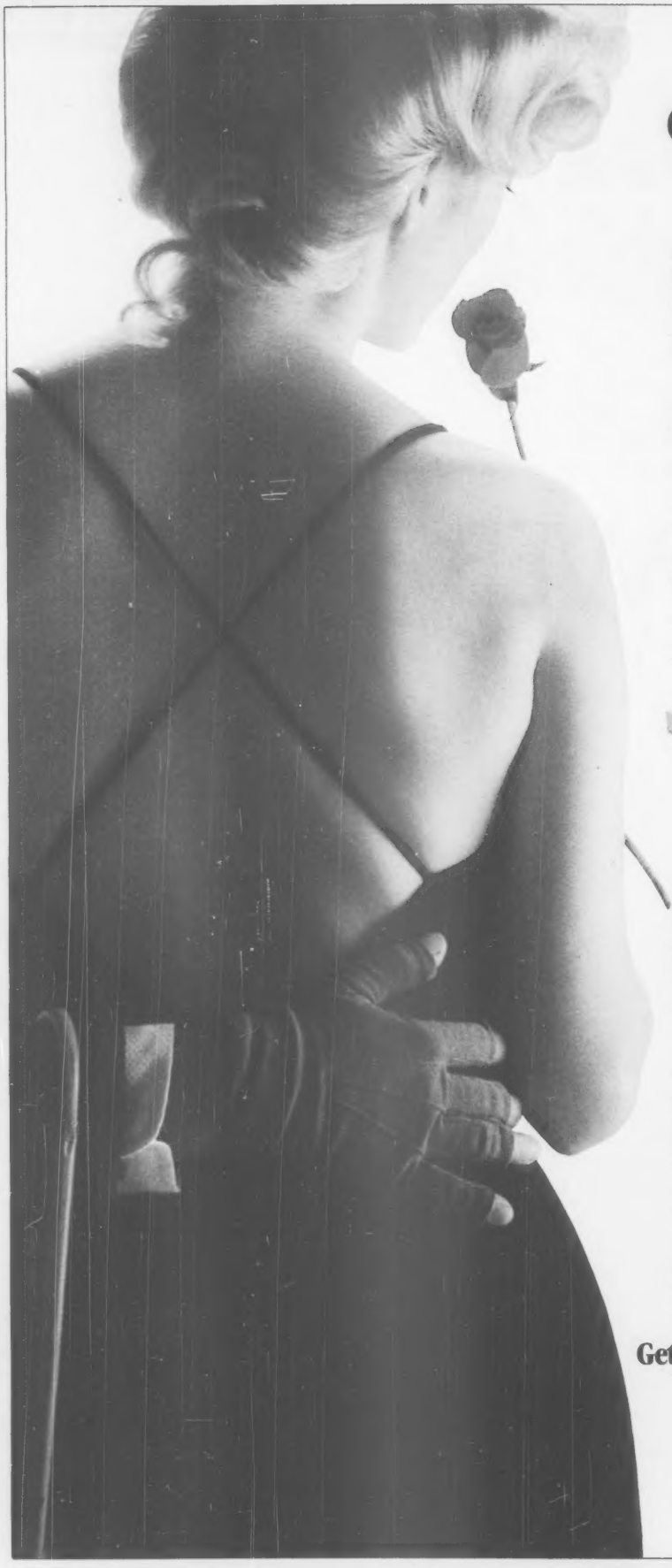

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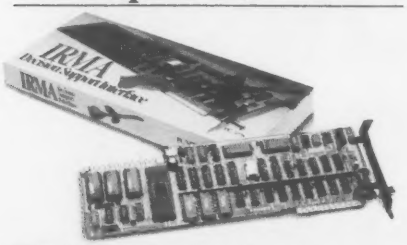

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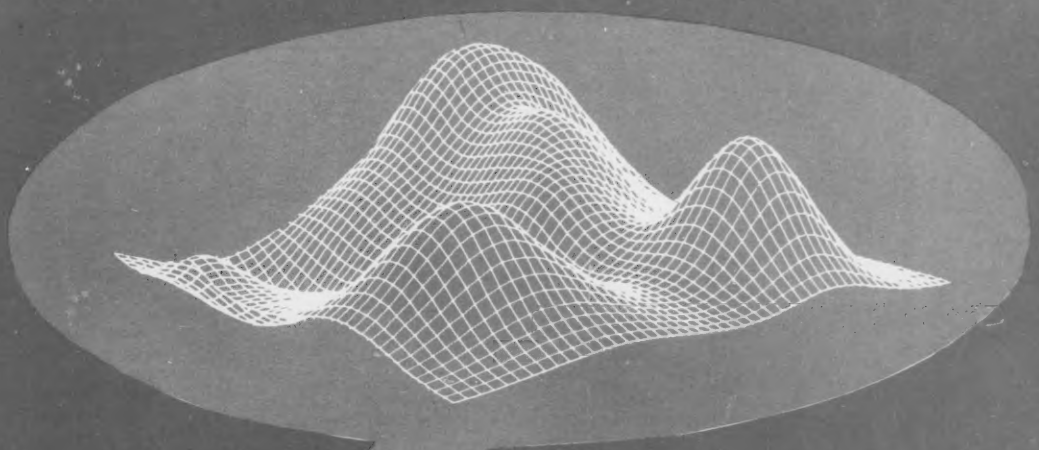


BY IAN ANGUS

INTEGRATING VOICE AND DATA COMMUNICATIONS

Until recently, the private branch exchange (PBX) was the poor relative in the business telecommunications family. It lacked the glamour of data communications; it had none of the mystique — not to mention the mysticism — of data processing.

While most corporations have long had full-time professionals, even departments, devoted to data processing and data communications, the telephone system has been left to its own devices. It is still common for corporations with multimillion dollar telephone bills to make PBX management a part-time responsibility of the mail-room staff. Data communications planners have looked down on or even ignored the PBX when soliciting or designing local data communications networks.

Recently, developments have ▶

made this situation intolerable. PBX technology is evolving at an ever-increasing rate. It is now apparent that the digital PBX, in one form or another, must play a critical role in a well-designed local network. Planners who ignore the PBX will find themselves with networks that are more expensive and less efficient than those of their counterparts who do not make that mistake.

It is common to describe the evolution of PBX technology in terms of generations. All pre-1975 systems are lumped into the first generation. The digital PBX systems introduced between 1975 and 1980, exemplified by Northern Telecom, Inc.'s SL-1 and Rolm Corp.'s CBX, are the second generation. The digital voice/data PBX systems announced between 1980 and 1982 are the third generation. A fourth generation is scheduled to arrive this year.

Despite an enormous amount of hype, the communications needs of many organizations can be met adequately by first-generation systems.

In fact, despite the enormous amount of hype to which advertisers have subjected us, the communications needs of many organizations can still be met adequately by electromechanical first-generation systems. The disappearance of these older PBXs, some of which provided reliable voice communications for more than 40 years, is more a function of economics than technology: They are too expensive to maintain now that replacement parts are no longer being manufactured and technicians are not being trained to service them.

It is important not to infer any value judgments from the use of the generation terminology. The generations are not as distinct as the public relations officers would like us to believe. The appearance of digital PBX systems in 1975 did not spell an end to the introduction of new analog systems. Some electronic analog systems introduced in the late '70s were in certain respects more sophisticated than the digital systems. And some of the third-generation systems lack features that are standard on second-generation systems.

Nevertheless, as long as it is remembered that the division between generations is not absolute, the terms do reflect certain changes that have taken place and do provide a convenient way of describing major technological trends.

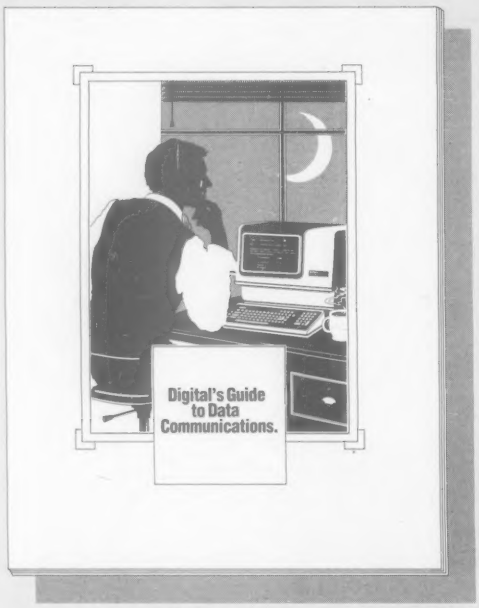
There is nothing new about switching data through a PBX. Users of electromechanical PBXs have been doing it for years. They simply connect each terminal to a modem and the modem to a telephone set. A transmission through a PBX passes through three states:

- **Terminal to modem: digital.**
- **Modem to PBX to modem: analog.**
- **Modem to terminal: digital.**

This technique does not, of course, merge voice and data. The telephone set may transmit voice or data, but not both at the same time. Anyone who wants to transmit data while making a normal phone call must have two telephones. If there are large numbers of terminals, this can seriously tax the capacity of the PBX.

There are more serious problems with this procedure. Despite remarkable advances in modem technology, modem-controlled transmission is limited to relatively low speeds. The need for multiple digital-to-analog and analog-to-digital conversions increases the possibility of transmission errors, and this possibility is further increased by the relatively poor quality of the transmission paths available in older PBX systems. For example, most Bell Canada 701 systems, which have been discontinued, are so noisy that users would be ill-advised to attempt speeds above 1,200 bit/sec through the switch.

North American telephone companies began converting analog signals to digital impulses for long-distance transmission during the '60s, but it was not until spring 1975, with product announcements from Northern Telecom and Rolm, that digital tele-



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phone reached the user level. Northern Telecom's SL-1 and Rolm's CBX brought digital encoding and time division multiplexing to the voice PBX marketplace.

But there remained the problem of the connection between the PBX itself and the telephone user. The new systems handled signals digitally inside the box, but all external communications, including communications to telephone sets on the system, were in analog form. Modems were still needed. In some respects, matters were worse than before because additional translations were needed with added potential for errors:

- **Terminal to modem: digital.**
- **Modem to PBX: analog.**
- **Intra-PBX: digital.**
- **PBX to modem: analog.**

These systems take advantage of the fact that the pairs of wires are not all used for voice.

- **Modem to terminal: digital.**

In February 1979, Northern Telecom announced its data communications feature for SL-1 systems. With an Add-On Data Module (ADM) at the terminal end, a special line card at the PBX end and a new software package, the need for multiple translations was eliminated. The digital output of the terminal could be inserted directly into the PBX's digital switching matrix. As a result, modemless data transmission had become a reality. Furthermore, there was no need for additional telephones: A set associated with an ADM could be used for voice and data communications simultaneously.

In Febrary 1981, Rolm announced a comparable enhancement for its CBX product line. A Data Terminal Interface (DTI), a Data Line Interface and some new software brought modemless data communications to Rolm customers.

Despite their superficial similarity, the Northern Telecom and Rolm data communications features approach data switching in radically different ways. Northern Telecom's approach may be called port multiplying: Each transmission — voice or data — is assigned its own 64K bit/sec time slot through the switch. Rolm's approach is port multiplexing: A 192K bit/sec time slot is subdivided according to the speed of the attached devices, allowing, for example, five two-way transmissions at 19.2K bit/sec or 40 at 2.4K bit/sec in a single time slot.

Each scheme is dictated by the architecture of the PBX involved. The SL-1's Time Division bus is modularly expandable: Its design allows addition of 64K bit/sec time slots as transmission requirements increase, so the simplest procedure was to assign one slot to each transmission, treating voice and data identically. The CBX's bus, on the other hand, has a fixed number of much larger (192K bit/sec) time slots, so multiplexing was a logical means of connecting many terminals without degrading throughput.

These systems take advantage of the fact that the pairs of wires that connect a telephone to a PBX are not all used for voice transmission. Northern Telecom normally uses three pairs of wire for each set — one for voice, one for signaling and one for pow-

Whisper Writer communicates via phone lines; an RS-232C version is also available.

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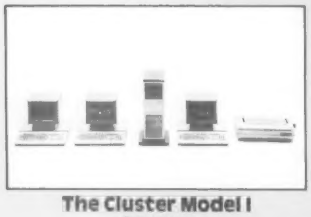

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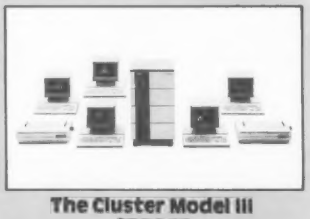

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er. The ADM places the digital data signal on the signaling pair, and no additional wiring is needed.

Rolm normally uses one pair of wires for a single-line phone and three pairs for the company's electronic multiline sets. The DTI requires two dedicated pairs for data transmission, so the system requires five pairs of wire to provide voice and data communications to electronic set users.

This limited cabling requirement is one of the strongest arguments in favor of using a PBX as a local-area network. Twisted copper wire is much less expensive to purchase and install than the coaxial cable used by most local-area networks, and since the twisted wire must be installed for telephone use anyway, the incremental cost of adding data communications to a digital PBX is usually much less than the cost of installing a separate cable-based, local-area network.

Speeds of 19.2K bit/sec asynchronous and 56K bit/sec synchronous are now available on second-generation digital PBX systems. This, together with the fact that PBX wiring is already connected to virtually every desk, makes the digital PBX the ideal means of integrating word processors and personal computers into a local data network.

An increasing number of organizations are planning for hybrid networks in which a digital PBX is used to connect casual users, while coaxial cable is used for data entry, programming and intermachine communications. Since twisted-pair cable is capable of handling up to 1M bit/sec, the need for coaxial cable may be very limited.

There remains the problem of cost. The equipment and software needed to add data communications to a digital PBX is expensive. It is often less expensive to install additional telephones and use modems, especially when only a few dozen terminals are needed.

With a great splash of publicity, Northern Telecom announced last year a program that, if it works, will break the cost barrier. Under the "Open World" banner, Northern Telecom is now allowing computer manufacturers to license key SL-1 specifications for a nominal fee. This will allow those manufacturers to incorporate the SL-1's communications protocols into terminals, eliminating the need for the costly ADM. Northern Telecom has so far signed agreements with Sperry Corp., Digital Equipment Corp., Data General Corp. and Hewlett-Packard Co.

Rolm appears to be following a similar policy, though with less publicity. DG and HP have announced they will make terminals that are directly compatible with the CBX.

This "Open World" program may prove to be the single most important development in voice/data telephony in the '80s. While cable-based, local-area network manufacturers squabble over standards and introduce mutually incompatible systems, PBX manufacturers continue the longtime telephone industry policy of working for total compatibility. The possibilities are enormous.

> ***The 'Open World' program may prove to be the most important development in voice/data telephony in the '80s.***

While Rolm, Northern Telecom and their competitors were announcing their data communications features, another group of companies was announcing entirely new systems. The first third-generation announcement came from Intecom, Inc. (an Exxon subsidiary), followed closely by Datapoint Corp., Lexar, Inc. and Anderson Jacobson, Inc. There are at least as many definitions of the third generation as there are manufacturers of third-generation systems, but there are two distinctive characteristics that set them apart from most of the second-generation systems:

- *Nonblocking architecture.* Most, but not all, second-generation systems are limited in the number of simultaneous connec-

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tions that can take place through the PBX; the number of time slots available is smaller than the maximum number of port pairs. Under heavy loads, some call attempts may be delayed or blocked. The third-generation switches are designed to allow every pair of ports to communicate simultaneously, with no throughput degradation. The importance of this feature is often overstated, but it does simplify system design.

• *End-to-end digital transmission.* All second-generation systems transmit voice in analog form to the PBX and digitize it there. Most third-generation systems convert the voice signal to digital form in the user's telephone set. If voice and data enter the set simultaneously, they are merged into a single digital bit stream in the set. No additional wiring, ADMs or DTIs are needed.

While the third generation of PBXs struggles to get off the ground, the fourth generation is waiting in the wings.

Although the third-generation PBXs were announced with a great deal of fanfare and excitement, few have been sold, and many of the manufacturers are finding that it is much easier to announce a PBX than to produce one.

Datapoint in particular has had major software problems on its ISX system; although the product was announced in April 1981, commercial deliveries are not expected until 1984. Similarly, software development has delayed introduction of Mitel Corp.'s SX-2000 until late 1983 — over a year behind schedule.

The one exception to this trend appears to be Intecom, Inc., whose IBX is now operating in a number of large customer sites and which now offers the largest range of voice/data features available commercially, including various protocol conversions and 3270 emulators.

Most recently, Intecom added Lanmark, a 512M bit/sec local-area network feature that operates within the IBX. In addition, it emulates Xerox Corp.'s Ethernet, using twisted-pair wiring.

While the third generation struggles to get off the ground, the fourth generation is already waiting in the wings. In the spring and summer of 1983, announcements of new systems are expected from small high-technology companies like Massachusetts-based Ztel, Inc.

These systems will combine the PBX features of the third generation with a high-speed, cable-based local-area network. The result will be truly distributed systems that combine voice and data transmission with office automation functions.

The need for very high throughput and reliability will probably lead the system designers to adopt an architecture that uses a token-passing ring to link several applications processors.

These processors may function as PBXs, office automation systems or both. Logically, the local-area network should follow one of the IEEE 802 standards to ensure an "Open World" environment.

A few years ago, a new firm entering the PBX market would have had little chance for success, but the changing regulatory environment in the U.S. changes that.

The fourth-generation systems will appear on the market just as the former Bell operating companies are looking for new products to replace their former Western Electric product line. One contract with a Bell operating company could turn a struggling high-technology company into a strong competitor in the PBX market.

With the arrival of the fourth generation, the distinction between PBXs and cable-based, local-area networks disappears, and the terms themselves will eventually become irrelevant.

It is altogether possible that the evolution of the lowly PBX will bring about the long-awaited office of the future. ■

Angus is a principal in Telsys Consultants Group, a telecommunications consulting firm based in Toronto.

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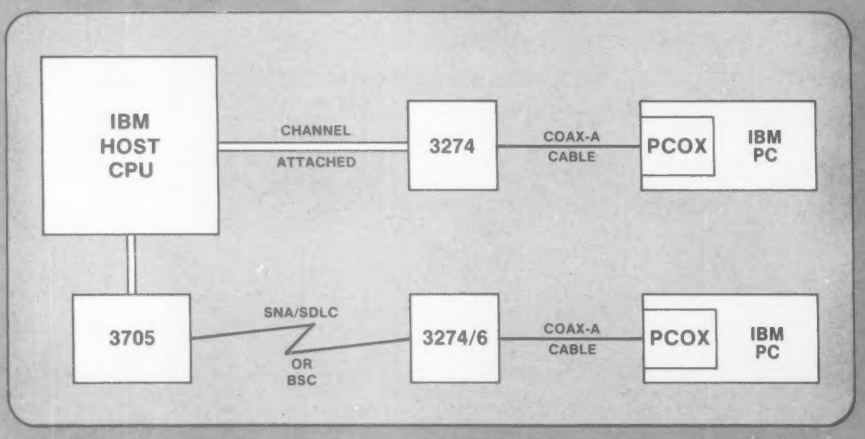

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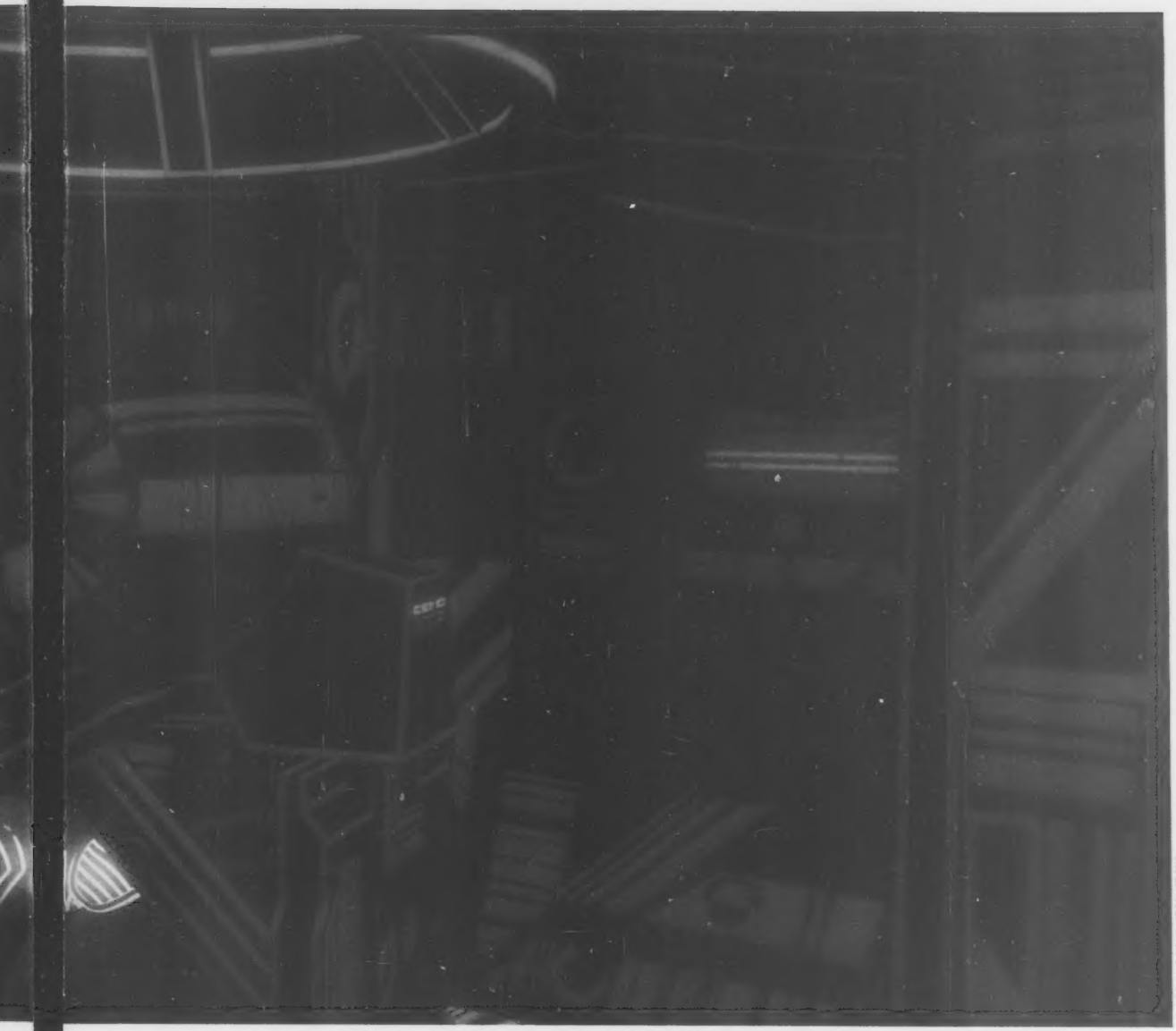
FUTURE NETWORKS

BY CHARLES P. LECHT

The methods we employ to provide ourselves with necessities of both high and low order cry out for change in a world gone electronic. Our increasing ability to deliver everything but material via electronic metaphor continually opens gates in the human-based data processing machine of which we are all a part. This machine, embracing over four billion individuals, has a distributed, collective brain in which more than 400 billion cells are massed. Roughly 90% of them are insulating glia; the remaining 10% is the stuff that counts — our neuron horde, in which, if you accept current theory, human intelligence is vested.

Each packet of 10 billion neurons per person is physically unconnected to the other except through the mediation of those genetic materials that make up our common biological inheri-



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tance or by presumably shared perceptions that we confirm by communicating our ideas about them in a wonderfully varied number of ways.

Together, we are an enormous, pulsating collection of brains united by bonds both weak and strong, intentional and instinctual, in which resides at any point in time the potential for any one member to discharge some form of communication to another. Such potential is defined by relational operators of endlessly fascinating, kaleidoscopic quality. It is easily at its most intense between parents and children, then between siblings, then within families and between them, extending to friends and acquaintances.

All other such potential takes the form of "principles" relating to the definition and communication of notions like race, religion, nationality, education and their uses in human society. In any event, no two brains have a connection as immediate, sustained, durable and reliable as that which is obtained between two devices situated at either end of a single cable.

Like massive chips, each with 10 billion factorial possible permutations for combining their elements, each of our brains must contend with communications problems wholly analogous to those bedeviling our premier invention — the computer. The equivalents of interchip spacing problems — intrachip overheating, breakdown, you name it — occur regularly. Indeed, the majority of these problems faithfully mirrors the lack of any reliable connection between two brains.

First by drumbeat, whistle or wordless cry, endowed with meaning by rhythm or inflection; then by spoken word or on stone, iron, wood and paper; and finally by broadcast, with or without wire or cable, people have ▶

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been forging ways to connect in order to communicate more efficiently. It is as though our id was compelled by an irresistible program embedded deep in human consciousness.

But when broadcast and wire came into the picture, a kind of organic network emerged. Pathways for interpersonal communications once closed were thrown open like the gates of a massive circuit, energized for the first time. Sound channels were born. They were followed by video, which provided channels for the transmission of visual stimuli. While experiments have taken place to open smell, touch and taste channels, these senses have been slighted when compared with sound and sight, reflecting our opinion of their relative unimportance.

Each communications innovation has reconfirmed a trend toward issuance of ever more faithful reproductions of the things being communicated: This trend seems to inform our behavior more than almost anything else.

What is important is that each communications innovation has reconfirmed a trend toward issuance of ever more faithful reproductions of the things being communicated: This trend seems to inform our behavior more than almost anything else.

According to Dante, "la verita e sublima" — the truth is sublime — but the view of the cosmos and man's place in it from which that philosophy sprang could have provided no clue to the advent of massive integrated services digital networks (ISDN) as vehicles for delivering the truth of which Dante spoke. And I do not speak about the mere traces left by truth that appear in the guise of words, photographs, movies and so on, but rather about the palpable reality set before us as though on a platter for endless contemplation.

The ultimate end of ISDN technology (another way of denominating the highly successful marriage of computers with communications technologies) is to enable holography to reproduce reality more faithfully without actually supplanting it. And when this happens, we need hardly be surprised that it will reduce the need for other modes of communication.

If a picture is worth a thousand words, then a hologram must be worth at least a million. The more reality we can communicate, uncompromised by the nebulous filters of human judgment and freed from the imputed need for decoration by the very system upon which we are depending for that same reality's accurate reissue, the better off we will be.

Digitized television, at present our best means for communicating reality, still introduces a sufficient degree of distortion to lead to skepticism about the quality of its end product (even though the technology is improving). While we can expect digital television to bear more reliable witness to reality than a superstition-ridden accuser at a witch trial in Old Salem, we cannot fail to observe its shortcomings in scope and dimension. Despite its admirable high resolution, digital television's lack of lateral and three-dimensional qualities will always leave us with the feeling that some part of our picture is missing, quite likely the most important part.

Of course, it can be enough merely to transmit symbols for reality: Conventional television, radio and even paper fulfill this function admirably. The underly-

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ing motive for the creation of communications systems is to convey both reality itself and the symbols whereby reality, acting upon our various senses, can reveal itself.

Just the same, we must strive to assign the transmission of reality through symbols to a lower rank in the pool of communications resources we employ in coming to grips with our true state. Symbols will always carry the seeds of ambiguity and thus magnify the possibility of error in situations in which error is not easily tolerated.

The emergence of a mature ISDN technology should materially improve our ability to recapitulate reality, for in the diversity of its delivery methodology and in its immense copying power lies the burgeoning seed of holography.

As dramatic and seminal an event as was yesterday's synthesis of computer and communications technologies, its kinship to tomorrow's developments is as remote as that which links the rough stone, as yet ignored in its quarry, to the immanent form that the sculptor will free from it with his chisel.

This synthesis merely established a platform from which we could reach out to establish a secure grip on yet more radically new methods for delivering the powers engendered by computer technology — electronically, rather than in the back of a truck.

The size of the remote computer services business before 1980 was minuscule compared with the user's then far more widely exercised alternative — to acquire his own computer systems in myriad sizes and shapes. The revenue-generating power of companies offering remote services remains unclear due to the existence of subsidiaries, the true extent of whose computer services revenues may be obscured by the accounting procedures of the parent company.

Nevertheless, it appears that, at best, the real revenues generated by such companies accounted for no more than 2% to 3% of the total computer industry-related revenues in 1980. And if the communications industry is included, such services have accounted for less than 1%.

Breakthroughs in the creation of networks to control sets of devices varying from dumb to intelligent terminals and from small to medium-size to large computer systems are changing all this. The availability of low-cost, high-speed communications between such devices and hardware/software scenarios for controlling their networked performance removes location as a factor in the formula used to calculate costs.

We must strive to assign the transmission of reality through symbols to a lower rank in the pool of communications resources we employ in coming to grips with our true state. Symbols will always carry the seeds of ambiguity.

This results in savings through device sharing, reduction of front-end costs for computerization and the economies of scale obtainable through massive utilities — especially where the bureaucracy usually associated with such collectives with monopoly status is absent.

Thus, widespread time-sharing of computer systems power is in the future, just as certainly as time-sharing of telephone exchanges was in 1914 when AT&T became a chartered monopoly. The dynamics of the change that is slowing down the delivery of discrete noncommunicating de-

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vices to our industry and is increasing the availability of the powers vested in these devices through communications links are faithful to nature and thus to be expected.

As letters have diminished in importance compared with other forms of message containment, with the telephone having just about reached the limits of its potential and improved its sound, the creation of networks of devices with dynamic configurability in the nsec/psec world will do the same to home office-based computer facilities. The economies of scale to be gained by shared facilities and the new services unobtainable without pooled resources will compel users to seek their DP support in networked device collectives.

Ranging from a time-shared micro sitting on a ranch in Cascade, Mont., capable of supporting only a few devices, to American Bell's Advanced Information Systems/Net 1000 ISDN and beyond, tomorrow's networks of devices will allow truly ad hoc real-time systems configurations tailored, perhaps on an event basis, to allocate resources to the task at hand in an optimal manner. Users will need little but the most comfortable, user-friendly I/O devices to meet their requirements. Their data processing chore histories, although prefiguring their future allocations in a manner less than perfectly accurate, once analyzed will still be far superior to what they could expect through other means.

In the mix of things, not all we do is motivated by economy, so not all home office-based systems will give way to time-sharing alternatives. Even those that do will not do so together (or altogether) — we would never allow everything to be in the public domain, although I dare say that more could happen with no shattering or negative long-term impact on any person or thing.

Carrying on in today's swiftly changing technological climate, we must dedicate ourselves to change or we will do naught but map yesterday's rituals with today's technology onto tomorrow's needs.

The employment of electronic means to perpetuate and even amplify outdated ideals is unworthy of our analytic and inventive powers.

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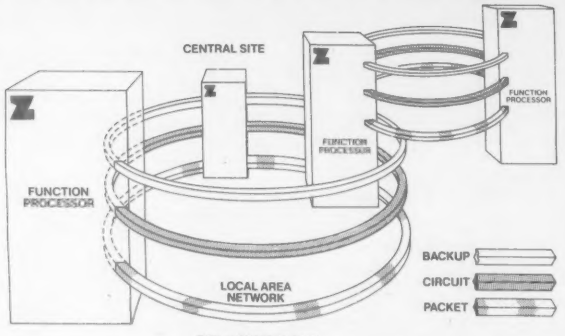

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The powers vested in these space-age communications systems will enhance their clarity and reliability to such a degree that single-decimal tuning will give way to double, triple, quadruple and so forth.

The number of channels for delivery of radio and television signals will multiply first by 10, then by 100, by 1,000, 10,000 and so forth. Whether on sideband or under a newly regulated bandwidth partitioning, enough radio stations are possible in the future to allow each citizen at least one for his own personal use.

Supported by the vast artificial intelligence repository of ISDN behemoths, signal receipt and delivery could occur virtually anywhere and at very low cost.

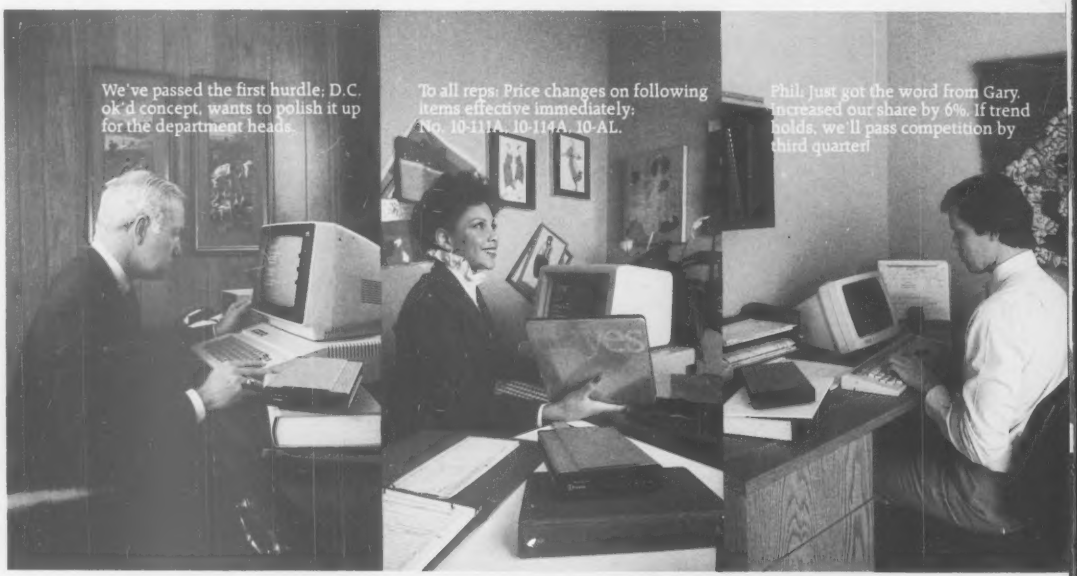
Television signal receipt and delivery could ultimately achieve the same ubiquity. With sound and sight digitized, its receipt and transmission is but a part of the ISDN's data processing dominion. Once television is capable of carrying signals from alarm to video and everything in between, the stage is set for the emergence of enhanced delivery systems wherein large-screen digital television can mix and match the video/sound experience from a variety of sources on the same screen. In addition to allowing viewing of several shows on a single screen at one time, interactive instrumentation of home-based artifacts, from keyboard to video camera, should allow real viewer participation.

Some of this is done already, even with analog video technology; assemblages of people in different cities who appear to be in one studio constitute a regular feature of today's news analysis programs. Only at great expense is viewer participation possible — but not for long. I envision television shows whose audiences are projections from home TV facilities, whose stars, too, are "at home" and whose management occurs through the control afforded by an ISDN environment. The empty studio television show is the first stage in the creation of future holographic assemblages, the realization of Walter Cronkite's vintage historical fiction, *You Are There!* — a distributed, not localized "there."

Digitized television will bring in its electronic train the entire gamut of possibilities inherent in the digital processing of data. Thus, ISDN service to a home or office will ultimately include alarm, radio, video, telemetry and so on. Not only will the signals of these be communicable to other locations, but artificial intelligence in the networks will provide us with enhanced experiences. For example, the viewing of events could be followed by computer-generated analyses of their meaning.

Imagine watching a baseball game and polling your television set for statistics on what has happened thus far. Or imagine a condor sailing high over the Andes and the measurement of its flight available on demand from an intelligent television set. In both cases, the television is not only passing on signals of sound and sight, but also keeping track of events as a human being might. As the ISDNs improve, they will serve the communications needs of individuals and groups in incredibly improved ways. Indeed, we will soon realize that, like artificial strength and intelligence, artificial communication will exceed that possible in today's natural world.

ISDN development causes heretofore discrete systems, local-area network cooperatives and other computer/communications entities to be stitched together. It is the result of the genius of laboratory engineers and scientists, who doubtless understand what it is that they are doing even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Hayes Smartmodems are available at two different speeds and price levels. The lower-priced Smartmodem 300 is ideal for local data swaps and communicates at 300 bps. For longer distance and higher volumes, Smartmodem 1200 transmits at 1200 bps or up to 300 bps, with a built-in speed selector that automatically detects transmission speeds.

We've also included indicator lights that let users see what their Smartmodem is doing, while an audio speaker lets them hear it. (Is the remote system down, or was the line just busy? This way, they'll know.)

Hayes has prepared a directory of the many communications pro-

though they may lack total or perfect foreknowledge of its consequences.

The core of each ISDN, a concept of administrative control independent of the strictures of physical location, is like the headquarters of a fast-moving corporation whose upper management is ceaselessly flying hither and yon.

Its power, vitally linked to the operation of arrays of processors whose interdependencies embody the latest — and frequently the most abstruse — mathematical formulas, derives not only from the power of each individual processor, but from the organizing principles of the processors themselves. Multiple systems, each disposing of massive power, will be electronically synthesized and capable of dynamic reconfiguration — sometimes via Fourier transforms — into functionally differing entities.

This capability will permit solutions to DP and communications problems to be optimized in a manner recalling the reactive streamlining of a spaceship subsequent to its launching.

The master control of an ISDN, a time-dependent concept of the residence of ultimate power within its effective domain, will satisfy a function not unlike that of a great maestro. In this context, it can be said to bear responsibility for shaping and eliciting the performance of not just one, but a multitude of works, such that each one derives maximum return from the tools making up the ISDN.

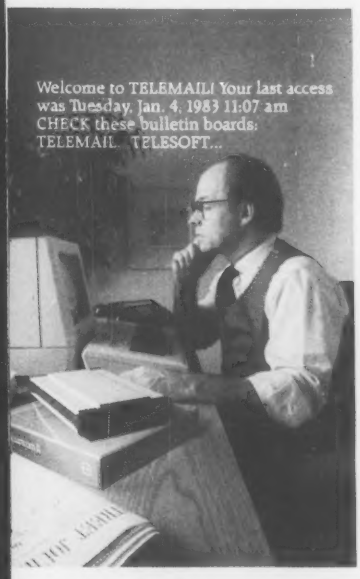
Subscribers to ISDN facilities will have no need to know precisely how any of this happens, any more than they now need to understand how large-scale integration circuitry actually operates in order to benefit from its exquisite, microcosmic architecture. In this case, too, the benefits will be enormous. With each ISDN terminal both a repository of computer power and a portal to other powers of greater or lesser consequence, data and the means for its handling will be available to users in whatever form suits their needs.

Reality sensors (input devices) will improve so much that sight, sound, touch and even taste and smell will be transferable between communicating ISDNs, with a minimum of intervention along their route. From the simple reading of an on/off switch to the creation of gigabyte representations of the sort that will be needed for future holographic reissuances, our input tools will draw closer to the actual input sources, sometimes actually melding with them for maximum efficiency and exactitude in transmission. Similarly, output devices will improve.

The operation of an ISDN in receiving inputs, processing them and providing outputs would impress even the most virulent antimachine fundamentalist with its beauty and economy. Committing and decommitting various system components to complete the task at hand, an ISDN, exploited to the fullest, should provide all the DP and communications excitement we can take — if we ever develop the empathy needed to appreciate what is happening within a system of such overarching nobility.

As today's ISDNs mature, we will link our government with industry, industry with education, education with people and people with people in increasingly ingenious ways. And when the last stage is reached — that is, when people are linked with their dreams — the transfiguration of humanity will take place. With each individual linked by far more than spiritual belief and our collective brainpower woven into a fabric of wondrous beauty by metallurgical, chemical and electronic shuttles working the loom of human genius and optimism, we will be able to strive with unparalleled intelligence and power for whatever is to follow. ■

Lecht is president of Lecht Sciences, Inc., a New York-based think tank specializing in computer and communications technologies.



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Dialing Capability: Touch-Tone and rotary-dial pulse dialing.
Commands: (unnecessary with Smartcom II software) A: Immediate answer. A/: Repeat last command. C: Transmitter Carrier. D: Dial command, including simple dialing, waiting for second dial tone, auto-dialing and other features. E: Local echo. F: Full/half duplex. H: Switch hook. M: Audio monitor. O: On-Line. P: Pulse dialing. Q: Quiet mode. R: Reverse originate/answer. S: 17 "Ser" commands allow user to select various operational parameters, such as dialing speed, escape code character, number of rings to answer on, etc. S?: Checks operational parameters above. T: Touch-Tone dialing. V: Verbose result codes.
Result Codes: (can be numerical/verbose): OK/0K: Command line ok. 1/Connect: Carrier detected. 2/Ring: Phone is ringing. 3/No Carrier: Carrier lost or never heard. 4/Error: Error in command line. 5/Connect 1200: Carrier detected at 1200 bps. (For Smartmodem 1200 only)
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Operation: Full or half duplex.
Data Rate: Up to 300 bps and 1200 bps for Smartmodem 1200; Up to 300 bps for Smartmodem 300.
Interface: RS-232C.
Intelligence: Z80 microprocessor with 4K byte control program for Smartmodem 1200; Z8 microprocessor with 2K byte control program for Smartmodem 300.
Modem Capability: Bell System 103 or 212A compatible originate or answer mode for Smartmodem 1200; Bell System 103 compatible originate or answer mode for Smartmodem 300.
Receive Sensitivity: –50dBm for Smartmodem 1200; –45dBm for Smartmodem 300.
Transmit Level: –10dBm.
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Appointed president of American Bell, Inc.'s Advanced Information Systems division last Jan. 1, Archie McGill serves as chief marketer of communications systems and services to business users for AT&T'S recently formed separate subsidiary.

The former vice-president of business marketing at AT&T has 10 years' experience at the firm. Before joining AT&T in 1973, he was in charge of product planning for the Data Processing Division at IBM, where he worked for 13 years. The AT&T veteran also spent four years as head of his own consulting firm. McGill was interviewed at American Bell, Inc.'s headquarters in New Jersey recently by Ronald A. Frank, managing director of Frank Communications Group, Mount Vernon, N.H.

ARCHIE McGILL

AN INTERVIEW BY RONALD A. FRANK

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ARCHIE McGILL

American Bell's President Archie McGill is in business to make "America's brainpower work more effectively and efficiently."

Undaunted by his somewhat elusive yet grandiose definition of his firm's goal, McGill is quick to stress that American Bell is not out simply to place new products on the market, but, more ambitiously, to change the very nature of the way business operates. "Why are we so brave to say that? We believe that information movement and management in telecommunications has as much potential as anything else to contribute to some of the basic problems that businessmen have."

What are these problems? Commercials and magazine advertisements for American Bell show automobiles in a salvage yard, frustrated business meetings that fail to get off the ground. The advertisements point to obsolescence and poor productivity, to a lack of sound communications management and productive information movement. But, according to McGill, the first step in addressing these problems lies in a conceptual rather than a strictly product-oriented approach. "When we started examining this telephone world . . . it became obvious that we had to define what piece we wanted to participate in because it was so broad and wide and segmented. The real opportunity for communications — for information movement and management — was to contribute fundamentally to the productivity issues.

"If we couldn't position ourselves in the productivity issues in a quantifiable way, we were not going to make a mark," McGill explained.

In order to address productivity problems and, ultimately, solve them, American Bell needed to nail down the roots of inefficiency in communications. Research conducted by American Bell showed that communications were transaction-based, and a study of those typical business transactions provided a clue to where inefficiency lay.

Firms were plagued by a lack of timeliness and responsiveness and, because of this, were losing key business in the competitive marketplace. McGill was confident that American Bell could take important steps to fill this void: "We saw that we had to be able to measure contributions — whatever we did — so that we could justify doing business with us."

However, the goal of identifying these broad issues with a newly formed communications company that provides equipment and services was somewhat elusive. McGill stressed that American Bell is "in the bottom-line contribution business — and that we intend to contribute to the customer's fundamental objectives."

But McGill, a former IBMer and longtime marketing strategist, admitted that a long-term solution does not lie simply in the conceptual realm, for the concepts must be backed up with workable products. The broad claims, he said, must sooner or later be tied to specific technologies and products. Any solution must eventually be applicable where it counts: in the office. "If you examine the specific application areas, the specific technology areas, it is very clear where we are going. We are in the voice and enhanced voice, data and enhanced data, sensor, the teleconferencing world and the office. Much of what we are concerned with involves the productivity issues where the transactions are crucial — in the office environment, the administrative arena."

McGill acknowledged that this is a fundamental reorientation of the way people have regarded communications. It is no longer a second-rate consideration: It is a critical resource. "In the past, we have looked at voice and communications in general as an expense to be minimized. We are saying 'No.' Communications has to be looked at as a critical management tool to achieve basic objectives. The more communications is positioned as the critical resource in the organization, the more it will be assimilated in the day-to-day fabric of business, and, therefore, the more it will be a fundamental contributor to where [the organization] is going."

Asked if this outlook is catching on in industry, McGill said that a few leading-edge companies are applying the principles to add value to their communications and "are winning the game." He cited Citicorp as a primary example of a firm that has used information to add value to corporate services and, thus, distinguished itself from the competition.

But at the same time, he admitted, there is much work to be done. He pointed to the role of corporate communications as a tangible measure of the importance attached to communications in a particular company. This role, he said, has been underrated in the past. It has not always enjoyed high visibility, but today it is "being elevated constantly."

With the role of corporate communications being changed in the eyes of top management, McGill

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said if telecommuncations managers "have a receptive management and if they position themselves on a mind set that their responsibilities are not to minimize the line item on the budget but to contribute to the bottom line of the organization and to its goals and objectives," they will enjoy a bright future.

Corporate communications should not simply rise in importance, McGill said, it should be in the forefront of the decision-making process. He envisions communications-oriented staffs involved with issues like strategic planning. "If they are not involved, somebody else is taking it. They are being led as opposed to leading. Information movement and management should lead — it should be out in front carrying other people. It's a fundamental growth issue for the people involved."

How will this happen? Education, McGill said, is the essential key to the realignment of the communications role in corporate strategy. In order to gain support from upper management, an educational effort is required. "There is some kind of mystique about information and computing in the senior executive; that mystique manifests itself in a stand-offishness. So any kind of familiarity, education or hands-on [experience] breeds understanding, and once you get into this stuff, it isn't that difficult," McGill said.

American Bell is taking steps to develop educational programs. Some basic courses have already been implemented for executive education, and a "relatively broad-based executive training program" is being implemented. On this level, McGill said, there is a need for "getting three to six days of really concentrated, immersed training so you get a feel for it — a comfort level with it."

Communication managers will be included in the educational plan; a reorientation is taking place at this level. In the past, these managers devoted themselves to keeping network facilities up and available. Now, with more reliable diagnostic and monitoring equipment, these managers can begin to think about closer interaction with upper management and corporate goals.

In this regard, McGill said, systems such as AT&T's Dataphone II are only scratching the surface. "We're very close to announcing some other help-aid [products] in that whole network management area," he said. "If we can get those problems routinized and the networks more reliable, then [users] can focus on more important issues."

Despite McGill's belief that the role of communications is increasing in its significance, most of these staffs report through DP and management information systems organizations. Rather than predicting coequal status between communications and computing organizations, the American Bell chief pointed out that there is a real possibility that "over time, the two roles are going to become obscure."

These traditional functions may be replaced by "whomever is best able to position himself as the corporate problem solver, whomever is best able to relate his activities and energies to the organization's objectives.

"You're going to see a molding together of all information and management into an integrated system going forward," McGill said.

The key element in tomorrow's multifunction systems will no longer be just a private branch exchange. Instead, McGill maintained, it will be a "premise-switching system that would be distributed in nature." The announcement of American Bell's Dimension AIS/System 85 marked a step in

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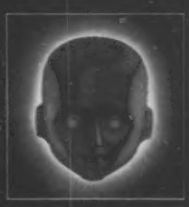

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that direction, McGill said. Even though the name "dimension" had the connotation of an analog switch, McGill said the name was chosen to show users that "we were thinking of them in terms of moving them easily into the future."

American Bell's conceptual strategy is evident in its products. Rather than introducing a product geared simply for an immediate solution, American Bell takes long-term user needs into account in its product designs. "We're going toward systems that are compatible upward, [so users] can grow from a simple system up through very complex systems," McGill said. "The button that you push to initiate a function or a feature will work the same on every system."

This process, however, takes time. McGill acknowledged that these concepts have already been implemented by other vendors. "Some people wonder where we have been. Some of our detractors would say we're a little late. What we did was make a conscious decision to take a delay in order to bring together all of [these features] under a single architectural umbrella. That was a huge sacrifice ... but we believe that it will [benefit] our customers over time."

The evolving American Bell product line will draw on outside suppliers. "We actually have some of that now. We are very interested in broadening our source of supply, and we're talking to several people."

The functionality found in today's personal computers will be part of the product line. While hesitating to say specifically that American Bell will have this type of desktop micro, McGill drew an analogy to functions that reside in data terminals. He pointed to Bell Laboratories' Get Set as an experimental device that "we installed to learn." While this will not be a final product, the hardware and applications concepts will be incorporated into a future integrated workstation. McGill said it will be "not only one, but a family of workstations" that will be compatible with existing equipment.

Turning to the recent start-up efforts of the American Bell division, its president said users would inevitably have interface problems. Noting that things will be different for users previously accustomed to dealing with one Bell system, McGill pointed out that these differences will be exaggerated when divestiture occurs.

To remedy this situation, American Bell will offer to manage the transition by acting as a central interface point. For a management fee, American Bell will, in effect, integrate user contacts with AT&T and other suppliers.

McGill said that users have come to expect a high level of service from Bell. "We are not going to ignore service. We really understand that if we do not provide high-quality service, we just won't make it."

But what about competition? McGill said, "Our largest competitors vary based on the different pieces of the marketplace. At the low end, the market is largely Japanese-manufactured equipment.

"At the high end, it's largely the Canadian companies and [Rolm Corp.]. In the middle, it's a mixture." Claiming that thus far American Bell has held its own, he added that "we will get more competitive over time. Our product line is evolving and we're working very hard."

But McGill said products are only part of the picture. "From a customer's standpoint, all I want to do is buy solutions. How the vendor chooses to implement those solutions, I don't care. I do not even ask what the technology is. I want to know about reliability, serviceability ... if it is going to stand the test, if it is user-friendly. Those are the criteria that I think are important." ■

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CONVERSING WITH COMPUTERS

BY CYNTHIA ADAMS

AT&T's Touch-Tone voice response is changing: It stands now at a threshold of growth. Advancements in supporting technologies and changes in the very nature of Touch-Tone voice response systems have had such a snowball effect that the industry is no longer limited. System costs are down, voice quality has improved significantly, high communications costs can be reduced and alternate devices are now supported.

Indeed, Touch-Tone voice response has overcome its most restrictive problems. It is now a viable solution for more applications than ever, and it is paving the way for growth in technical communications.

Touch-Tone voice response is a method of data entry and inquiry in which a user enters data or requests information by pushing the buttons on a Touch-Tone telephone. The ▶

computer speaks to the user in a real human voice, using words and phrases that have been stored electronically. It greets the user, asks for a piece of information in the data entry process, optionally repeats what was entered and alerts the user to any errors or unusual conditions. It also allows the user to correct any mistakes.

In our fast-changing technological world, new ideas breed newer ideas and technical improvements stimulate more technical improvements. These changes affect every technical industry, including Touch-Tone voice response. It is time to take a new look at this method of data collection and inquiry and see where it is today and where it is going tomorrow.

Today's technology is changing so rapidly that an industry's very survival is critically dependent on its ability to adapt to new methods and concepts. Touch-Tone voice response, a concept that caught on slowly at first, has used technology's changes to its own advantage and has built itself into a serious and competitive industry. By overcoming its initial problems, this industry has become a powerful solution for data entry and inquiry.

System costs have been reduced substantially. The high hardware and development costs of a Touch-Tone voice response system were perhaps the most limiting factors of the industry in its infancy. The concept did not catch on because few companies could afford to use it.

Hardware costs have played a big role in the industry's development. Touch-Tone voice response systems once cost from $150,000 to $250,000. For some systems, just the audio response option was an $85,000 investment. Today, with the well-known decrease in hardware costs, total turnkey Touch-Tone voice response systems are available for under $100,000.

In addition to the drop in hardware prices, development costs have shifted from customers to manufacturers. In the early days of Touch-Tone voice response, electronic communications was so new and complex that customers had to develop their own systems; thus, costs were outrageously expensive.

These massive projects required whole staffs of programmers and engineers and often took a year or more to complete.

With the reduction in hardware costs and advancements in technology, system integrators have entered the market and can now provide affordable turnkey systems in 45 to 60 days. Many of these are total systems, including hardware, software, installation, training manuals and maintenance. The net result is a complete system, and it is delivered with no fuss, no muss, no additional staffing requirements and no hidden expense costs.

Today's technology is changing so rapidly that an industry's survival is dependent on its ability to adapt to new methods. Touch-Tone voice response has used technology's changes to its advantage and has built itself into a serious, competitive industry.

In addition, payout has improved immensely and dramatically. Even with reduced system costs, a Touch-Tone voice response system still represents a fairly significant investment for any firm, and the cost must be justified accordingly. Payout naturally varies with the particular application, but in general, most systems pay for themselves in two years or less. This is a dramatic

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improvement over past years, and the trend will continue.

The cost of a manual data entry method is rising. Salaries and benefits continue to rise, telephone and mail costs keep increasing and competitive pressures make customer service crucial. Since a Touch-Tone voice response system virtually replaces a manual system, the payout of a Touch-Tone voice response system is improving drastically compared with a manual system.

Order entry, one common application, is a clear example. Under a manual system, orders are called or mailed to the home office by salespeople, customers or both. The handwritten orders are keyed or keypunched, checked for keying errors, corrected and finally submitted to the computer. Under a Touch-Tone voice response system, customers or salesmen in the field enter their orders directly to the computer, saving mail time and allowing salesmen to spend less time writing orders and more time selling products.

Many users associate 'voice response' with the unnatural, computer-generated voice characteristics of synthesized speech. In the early stages of Touch-Tone voice response, synthesized speech was the only affordable voice selection for most firms.

Furthermore, telephone calls are considerably shorter; the need for a keypunch department is drastically reduced; and costly errors are virtually eliminated since the data comes directly from the source.

In the above example, the manual system and the Touch-Tone voice response system both required telephone calls. If the data came from long-distance users entering extensive orders, the voice response system's speed would naturally be a cost savings over the manual method. In addition, Touch-Tone voice response has kept pace with advances in technology. Communications costs can be reduced for Touch-Tone voice response systems, improving the payout even more.

High-technology firms have introduced store-and-forward and batch-buffered terminals, which can reduce communications costs by as much as 50%. These terminals allow a user to store data off-line at his convenience and transmit it rapidly later, either a single line at a time or a block at a time. In addition, communications costs are reduced because of the off-line data entry; the user can check and double-check his entries for accuracy before he ever calls the system. As a result, fewer calls are canceled and reentered due to errors.

Not only have the costs and payout improved for Touch-Tone voice response systems, but the vocal quality of those systems has increased as well.

Many users associate "voice response" with the unnatural, mechanical, computer-generated voice characteristics of synthesized speech. In the early stages of Touch-Tone voice response, synthesized speech was the only affordable voice selection for most companies.

Digitized voice, stored on magnetic media, was far too expensive. Some companies stored digitized voice information on a film drum, much like the sound track on a sound movie projector. This method was less expensive than disk storage, but had strict storage limitations. Other companies stored single words on disk and combined words to generate the necessary messages. This produced choppy, mono-

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tone voices that were not well accepted by users.

In recent years, however,. hardware costs have come down even more, and the audio response industry has fine-tuned its digitizing capabilities. High-quality digitized voice can now be affordably stored on disk or random-access memory, providing plenty of memory for storing entire phrases and messages for even the most extensive vocabularies. The result is a smooth-flowing voice, well accepted by users, at a reasonable price.

Until recently, the vocabulary for most Touch-Tone voice response systems was fixed — that is, it was programmed into programmable read-only memories and could not be changed without reprogramming that hardware. The voice response part of a system was a front-end system, separate from the processing computer. This allowed plenty of room for telephone lines but restricted the flexibility of a system.

Now, users have a choice. With new digitizing algorithms and with lower hardware costs, vocabulary is now variable and virtually unlimited; it is stored on disk or in memory and can be changed at will by voicing the new word or message through a microphone or right over the telephone. Users no longer have to go back to the manufacturer to change their vocabulary.

In addition, variable vocabulary offers users limited voice mail capabilities, such as the ability to voice different messages to different users depending on location, size, credit rating or other predetermined criteria.

For example, a Texas-based trucking service has a Touch-Tone voice response system that links the company to its truck stop network and captures information at the time and place of purchase.

This particular system has the capability to send personalized messages to truck drivers, who are identified by their credit card numbers. At the end of a transaction with the Touch-Tone voice response system, the computer checks for any pending messages for the driver. If there are messages, using voice response, the system tells the driver the appropriate telephone number to call.

In the early days of Touch-Tone voice response, communications technology was less advanced than it is today. Few computers were compatible, and transferring data between systems was difficult. Today, however, most systems can support multiple communications protocols: They can communicate directly with various other computers and devices simultaneously.

This, coupled with the decreasing costs of hardware, allows Touch-Tone voice response solutions to be practical in many distributed environments as well as in centralized environments.

In the true distributed environment, duplicate Touch-Tone voice response systems can be installed at each site to communicate with the processing system. In some cases, however, a single Touch-Tone voice response system can communicate with each remote site simultaneously. A large pharmaceutical firm uses the latter method to collect and process orders from over 1,000 salesmen. A central Touch-Tone voice response system handles the calls and collects all the orders that come in, but five distribution centers process the orders. At regular times every day, each distribution center's computer polls the Touch-Tone voice response system to gather all the orders assigned to that particular distribution center. Order processing then begins at each location.

In the centralized environment, a Touch-Tone voice response system

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communicates with the single central processor. A Midwestern convenience store chain, for example, uses the centralized approach to collect gasoline orders, grocery orders, daily sales reports and payroll reports from each store in the chain. Each individual store calls the Touch-Tone voice response system to enter its data. The system handles all calls for all four applications simultaneously and submits the data periodically to the host computer for processing.

The extent of Touch-Tone penetration is greater now than ever before: More than 60% of the telephone offices in the U.S. support Touch-Tone, especially in metropolitan areas, where Touch-Tone voice response systems collect much of their data. In addition, networks that depend on Touch-Tone, such as MCI Communications Corp.'s Sprint, and the attractive option of credit card calls are encouraging more and more individual companies to favor Touch-Tone. Inexpensive handheld Touch-Tone pads are also available to give any telephone the capability of emitting Touch-Tone signals. Greater Touch-Tone availability means more potential users for companies considering Touch-Tone voice response.

So where is the industry now? If all these improvements have taken place, many different applications should be well suited to Touch-Tone voice response. What are they? The list is long and growing longer:

- Data entry — applications such as field-service reporting, order entry, sales reporting, payroll reporting and inventory reporting.
- Inquiry — applications such as flight status, credit authorization, product availability, bank account status and order status.

Touch-Tone voice response systems are well suited for many different applications in a vast multitude of industries. So how does a potential customer determine whether or not his application is appropriate for Touch-Tone voice response? There are three general guidelines to consider when evaluating an application.

- Whenever critical information is being collected, Touch-Tone voice response should be considered.

Furthermore, Touch-Tone voice response is a powerful solution when data must be collected on a timely basis, when accuracy of data is essential or when immediate feedback is beneficial to the user.

If data is time-critical, Touch-Tone voice response can make a vast improvement on a manual system by eliminating the time needed to collect data by mail and the need to keypunch the data.

Touch-Tone voice response ensures accurate data by its on-line validation and its vocal response. Users are able to hear what they have entered and may edit any errors, and they are alerted at once if hash totals do not agree or if other error conditions occur. Immediate feedback can be beneficial to users, especially in applications — such as order entry — in which it is possible for the system to inform the user of back-order or out-of-stock conditions on items in the order.

- If the system must be convenient, Touch-Tone voice response is a solution.

Convenience takes many forms with a Touch-Tone voice response system. With 24-hour access, seven days a week, users may enter their data whenever they desire from any telephone set.

Highly mobile users, users with extremely tight schedules and users in various time zones all have convenient access to the voice response system. Touch-Tone voice response systems require no in-

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vestment in special terminals: A Touch-Tone telephone or device is all the user needs. No terminal could be more convenient and none could be easier to use.

- If the system's environment is dynamic, Touch-Tone voice response is a solution.

The system's convenience blends well with a changing user environment, while its variable vocabulary is well suited to dynamic information.

A Touch-Tone voice response system is so easy to use that no special training is needed, even for users with no computing experience. No memorization is required: The system prompts the user for every step of the data entry process. Thus, Touch-Tone voice response is attractive to customers who have a high turnover of users, infrequent users or young and inexperienced users.

Several companies have constantly changing information that must be readily accessible for users. Touch-Tone voice response is an excellent solution for many inquiry applications, such as bank account status, credit status or authorization and product availability. In addition, Touch-Tone voice response provides a way for companies to inform users of information changes that are normally less dynamic, such as price changes or special discounts.

It seems that Touch-Tone voice response has overcome its most restrictive problems and is now a viable solution for many different applications in many different industries. The next questions are obvious: What will happen next? How will technology change? The answers are already beginning to surface.

Touch-Tone voice response will support new devices and functions, allowing users to upgrade as their needs grow. The rapidly emerging concept of voice mail, already used in a limited way, will become an integral part of Touch-Tone voice response systems. Since vocabulary is now variable, future developments will allow Touch-Tone voice response systems to include a voice mail option, through which the customer could record a message and send it to his users.

System manufacturers are taking this concept one step further. Equipment that will allow a variety of input devices — telephones, Touch-Tone pads, CRT terminals — to access a system via the same telephone line is being developed.

Currently, customers must provide a separate phone line for each different device. Sensitive new equipment will be able to recognize the data entry device as soon as the system answers a call, even before the user enters any data.

Customers will need fewer phone lines to collect data and will still be able to handle unique devices differently.

It seems obvious, then, that Touch-Tone voice response systems will not limit a company to voice response. On the contrary, they will provide companies with a growth path, allowing them to expand beyond voice response when their needs move toward other kinds of communications, such as device-to-computer or computer-to-computer.

But these voice response systems will not only encourage companies to move toward higher technology, they will also encourage users to make that move. ■

Adams is publications manager for Interface Technology, Inc. in St. Louis.

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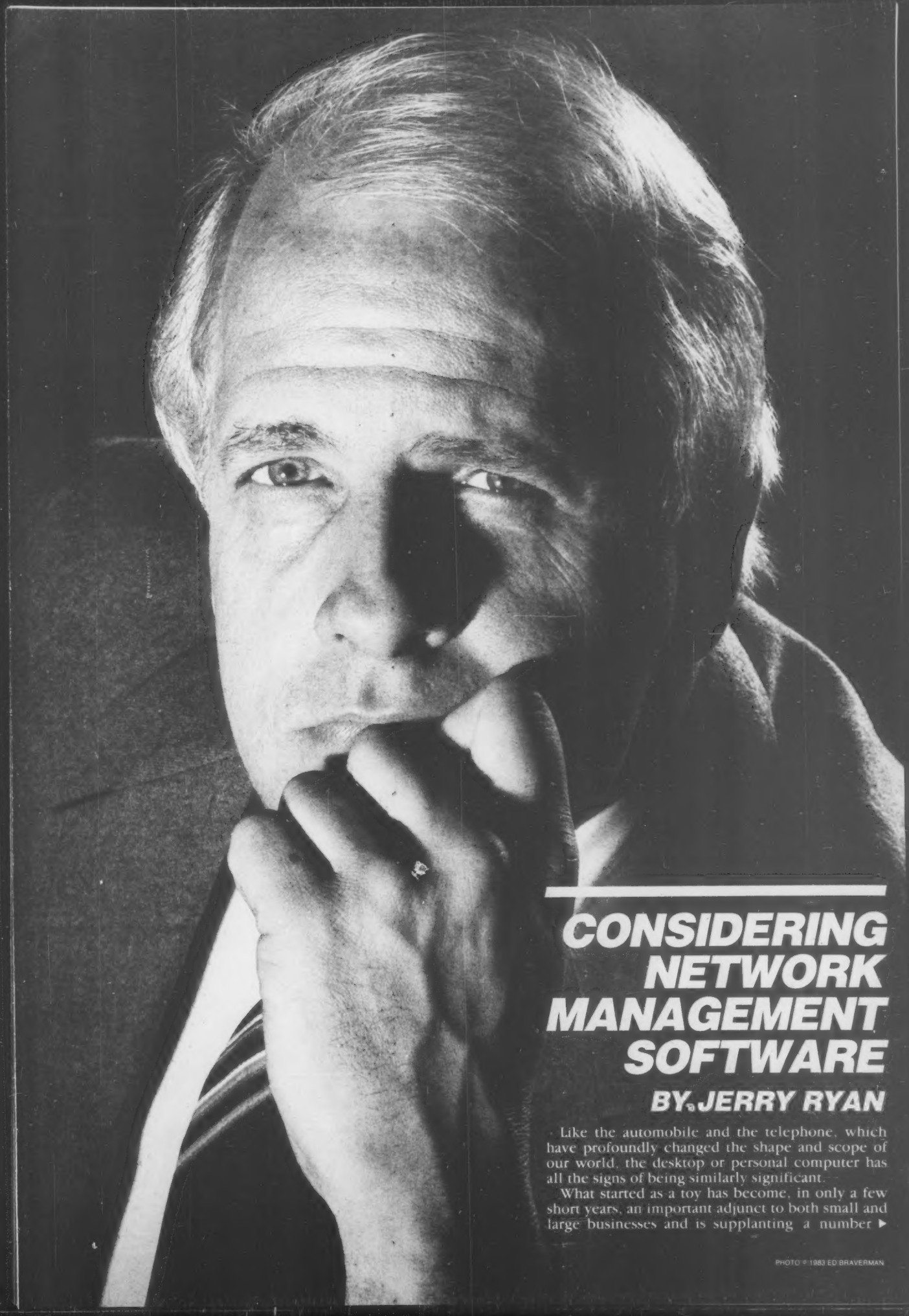

CONSIDERING NETWORK MANAGEMENT SOFTWARE

BY JERRY RYAN

Like the automobile and the telephone, which have profoundly changed the shape and scope of our world, the desktop or personal computer has all the signs of being similarly significant.

What started as a toy has become, in only a few short years, an important adjunct to both small and large businesses and is supplanting a number ▶

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CONSIDERING NETWORK MANAGEMENT SOFTWARE

of established, honored mainframe applications such as financial modeling, sales forecasting and inventory control.

In the midst of this revolution, a steadily increasing number of users have recognized that the availability of personal computers has opened the door to tremendous improvements in management capabilities of the more highly specialized management functions within the corporate structure. Among these users are the telecommunications managers of corporate communications systems — specialized managers who have been regarded as stepchildren by their data processing peers.

For years, teleprocessing managers have had a real but unmet need for information processing capability. These people, whose job regularly entails overseeing millions of dollars of the corporate budget, have never been able to justify the in-house development of their required management aids, simply because they did not have the wide or pervasive applicability needed to justify the programming effort or mainframe usage. As a result, the telecommunications managers — and this includes both the voice and data people — were left to fend for themselves.

This lack of adequate automated support for their functions created a number of less-than-satisfactory situations. A trend developed toward almost total dependence on teleprocessing equipment vendors for even the simplest of network design tasks, such as determining network topology or specifying the number of trunks needed to meet a vaguely specified grade of service.

On the voice side, it became a standard procedure to recruit telephone company employees to manage the telecommunications department because they were the only people capable of understanding and dealing with the complexities of telephone company jargon and recommendations. On the data communications side, there were similar problems with dependence on vendor-provided design and management systems. Because of this vendor dependence, there was almost no development effort toward software packages that could support voice or data communications managers.

To fill a portion of this gap, companies such as Contel Information Systems, Inc. and the Aries Group and others began to market time-sharing-based network design packages that, although highly effective, were aimed at only the top 10% of the potential user population. This left a tremendous gap between the needs of the average telecommunications manager and the system resources available to meet his needs.

This problem was also pervasive and perhaps more damaging for voice systems because, although much more of the corporate telecommunications budget was spent on voice services, there were fewer third-party systems available.

This is beginning to change dramatically due to the wide use of personal computers in business. Managers no longer have to depend on their own in-house DP centers, outside service bureaus or hardware vendors to get their job done efficiently and accurately. This stems from the development of industry-specific applications that run on personal computers and meet the needs of the typical manager.

These software packages, which deal with the tasks most often associated with telecommunications management, can be categorized in the following five major areas:

- Predictive performance modeling.
- Topological optimization.
- Trunk grouping analysis.
- Network technical control.
- General management.

The typical application allows the network designer to predict the effect of multiple on-line applications on the corporate network and the decay or improvement of terminal response time due to changes in the traffic flow within a network. It allows the designer to ask "what if" questions regarding possible protocol changes, transmission speeds, message structure and intermixed traffic types and to compare the results within seconds. With such an application, a designer can usually keep one step ahead of the network growth and can steer its direction effectively.

Performance modeling tools for personal computers usually run on 64K-byte systems and are typically based on queuing formulas rather than on network simulation exercises.

Although simulation programs are usually more precise than modeling systems, particularly in atypical, nonstandard applications, the increased degree of precision is usually unnecessary and extremely time-consuming for most users. Modeling systems, which depend on proven statistical mathematics, provide the user with accurate and usable "apples to apples" comparisons adequate for most corporate network applications.

In general, these applications allow the user to modify any network characteristic in a variety of combinations and to see possible network opportunities or pitfalls.

Usually, these applications provide graphics to illustrate performance decay parameters, comparisons of network functions and the distribution of predictable response time throughout a specified time period.

In today's complex on-line environment, corporations are spending millions of dollars to connect their widely scattered corporate terminals to a variety of network nodes and processors.

The method in which these terminals are connected, usually in multipoint long-haul circuits, can result in significant and unnecessary cost overruns due to inaccurate routing decisions and can also result in dramatic service degradation.

As a result of the Bell system deregulation, there has been a need for network systems users to do their own network layouts. Personal computer-based software packages give them this capability in a structured and accurate way. Using IBM's Esau-Williams algorithms, these packages can usually handle up to 200 nodes on a 64K-byte system and over 500 nodes on a 256K-byte system.

Personal computer-based software can provide the ability to enter competitive tariffs and do a series of price comparisons to determine the optimum least-cost route. Some packages allow the user to do multiple iterations using a variety of multiplexer arrangements and provide the capability to connect to multiple host needs.

In a typical corporate network, there are hundreds of nodes — or clusters — with perhaps thousands of terminals connected through them to the host CPU. The usually conservative manager, not realizing potential options available to provide a balanced and cost-effective mix of terminals and lines, often opts for a series of point-to-point circuits from the host directly to the cluster locations, with perhaps some effort to multiplex coterminous controllers. This approach provides a good level of performance because individual line utilization of any circuit is low enough to eliminate all but the most occasional queuing delays. The price, however, has been unnecessarily high.

With new software now available with user-friendly screen formats and prompts, these underutilized networks are unnecessary.

In fact, the cost of a typical network can be reduced, in some cases by as much as 75%, by simply allowing the software system running on the internal personal computer to reconfigure the network layout.

Managers of voice networks have historically depended on the telephone company to provide information about the number of trunks or Wats circuits needed on the corporate private branch exchange (PBX). Today, however, with highly competitive PBXs incorporating complex and sophisticated features such as automatic route advance, queued calls, priority services and tandem network switching, these answers are not enough.

More than any other telecommunications managers, voice network managers are faced with a highly complex range of network design alternatives.

Questions about the proper mix of trunk types, the integration of priorities and queuing demand technical depth that can only be supplied by the personal computer.

Certainly, there are some time-sharing design aids available, but these, just like the data network support packages, are costly and are intended for the top 10% of the marketplace.

Voice network design software is now available for use on the most common personal computers, such as the Apple Computer, Inc. Apple II or the IBM Personal Computer. These applications allow the designer to enter all the traffic variables and to determine the correct number of each type of trunk needed in a complex PBX. In some cases, they also allow the user to input directly the telephone calling record usually available from the newer PBXs and to have the system do a direct analysis of calling patterns to determine the correct mix of trunks.

The more sophisticated programs will also do some analysis of off-net calling in a multiple-node PBX environment. This will allow the network manager to provide a comprehensive and cost-effective network plan for corporate voice traffic without having to use a vendor-provided design service.

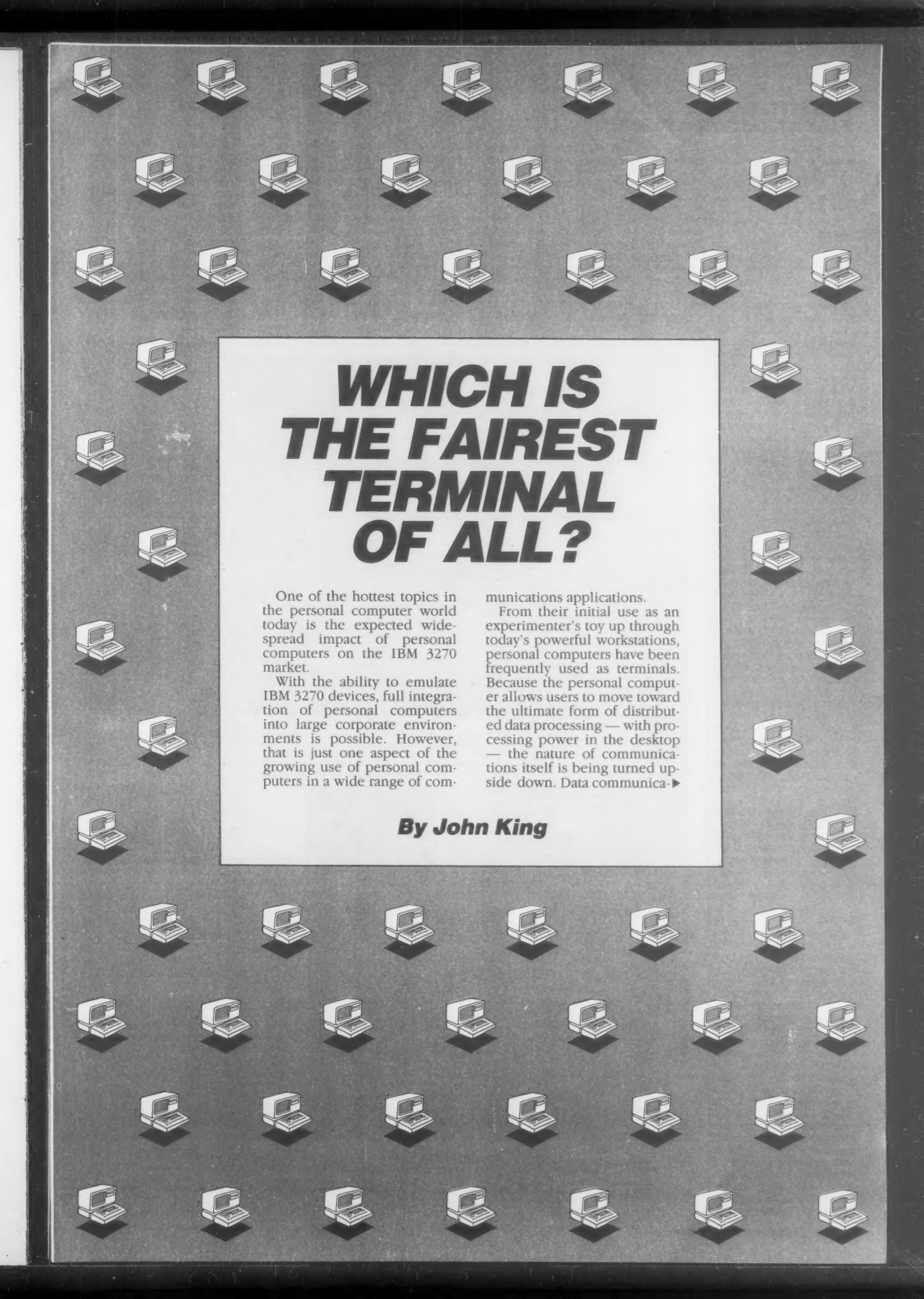
Until the introduction of software for the personal computer, technical control was almost totally the domain of hardware vendors. These systems, developed around a vendor-specific technology, tended to lock the user into particular products of the vendor while limiting the functions to hardware monitoring and switching. There has been a significant lack of software applications that provide diagnostic methodology and detailed network data base information.

This is a new area being addressed by software packages designed for personal computers. Within a typical application, the user, under prompting of the program, can develop a thorough and wide-ranging set of diagnostic procedures that can include fault isolation, escalation procedures, backup invocation, corrective action to be taken and statistical reporting on the network performance.

A number of generalized software packages such as Visicorp's Visicalc are available for spreadsheet applications, but the user has to spend a lot of time tailoring them to meet unique network needs. Most communications managers believe that inventory record-keeping and related problems of billing and in-house charge-back arrangements represent one of their biggest headaches and are too complex for off-the-shelf generic packages.

They also cite the unique staffing problems of the telecommunications world and budgetary analysis and long-range forecasting as some of the important software applications designed for the personal computer. ■

Ryan is president of Connections, Inc., a Hanson, Mass.-based software company specializing in network design and management.



WHICH IS THE FAIREST TERMINAL OF ALL?

One of the hottest topics in the personal computer world today is the expected widespread impact of personal computers on the IBM 3270 market.

With the ability to emulate IBM 3270 devices, full integration of personal computers into large corporate environments is possible. However, that is just one aspect of the growing use of personal computers in a wide range of communications applications.

From their initial use as an experimenter's toy up through today's powerful workstations, personal computers have been frequently used as terminals. Because the personal computer allows users to move toward the ultimate form of distributed data processing — with processing power in the desktop — the nature of communications itself is being turned upside down. Data communica-▶

By John King

WHICH IS THE FAIREST TERMINAL OF ALL?

tions evolved from dominance by large mainframes connected to a few terminals. Today, many organizations are able to view their network as independent of computers and terminals.

Personal computers, including multifunction workstations, have replaced terminals as the fastest growing segment of the computer business. In fact, many personal computers are addressing what would have been applications for terminals. Even the humblest personal computer can be as powerful and flexible as an expensive intelligent terminal of just a few years ago.

Turning a personal computer from a stand-alone device into a communications device requires hardware and software. The hardware is typically an add-on printed-circuit board that fits into one of the personal computer's expansion slots. For instance, a printed-circuit board might provide an external interface and asynchronous communications. But hardware alone does nothing. There must also be software that sends and receives data to and from the communications board, displays and stores data and simulates the capabilities of a terminal or other device.

The personal computer is an effective chameleon. Using only one communications board, the personal computer can function as a variety of devices by using different software.

Before examining the important uses of personal computers as communication devices, it is necessary to review the basics of data communications. All devices operate using specific modes, codes, protocols and external interfaces.

Mode refers to how two devices, one sending data and the other receiving it, are able to operate at the same speed. If a phonograph is turning too fast or too slow, the music sounds funny. Likewise, a sending device (the record) operates at a given speed with the expectation that the receiving device (the phonograph) will operate at the same speed.

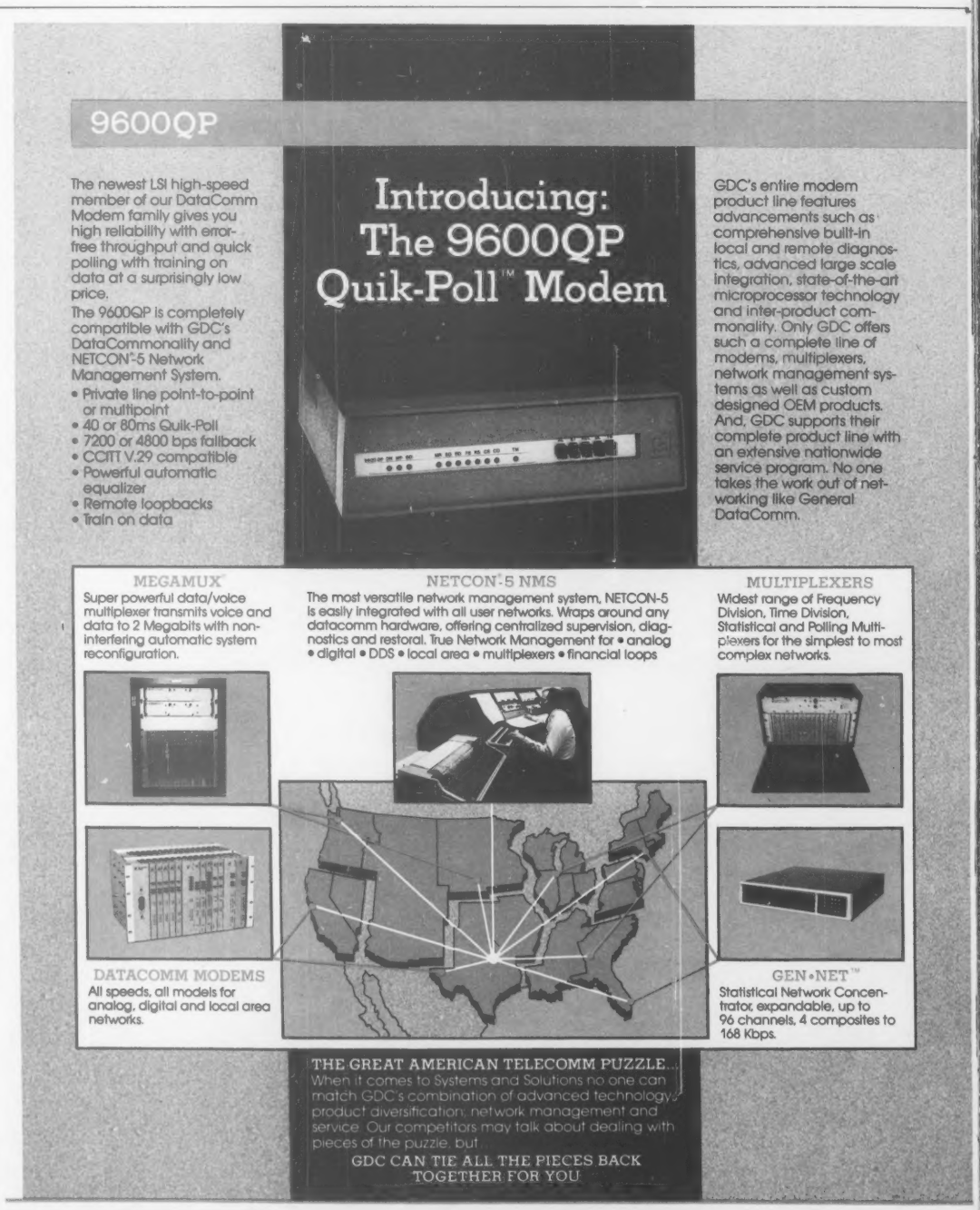
Asynchronous devices each have their own clocks. When a character is to be sent, the sending device starts its clock and sends characters at a predetermined clock speed. In this mode, a start bit precedes the data bits for each character. The start bit signals the receiving device to start its clock, which must be preset to operate at the same rate. Synchronous devices, on the other hand, do not usually have clocks. Timing is received from the modem or other equipment. Such communications modems have the capability of synchronizing their clocks. This permits large amounts of data to be sent without requiring clocking bits to surround each character.

Code refers to the sequence of bits used to represent a particular character. There is a wide variety of codes, from Morse to Baudot to Ascii and Ebcdic, but only the last two are of importance today.

Ascii refers to the American Standard Code for Information Interchange. Ascii requires seven bits to represent a character with an optional eighth bit for parity (to check whether the sum of bits for a character is odd or even). Ascii is used by almost all asynchronous devices, from 110 bit/sec teletypes to 9,600 bit/sec VT100s from Digital Equipment Corp.

Ebcdic is IBM's 8 bit/char. Extended Binary Coded Decimal Interchange Code, introduced along with the 8-bit byte in 1964 as the basic memory unit of the IBM 360. Since almost all computers today are organized around 8-bit byte memory structures, Ebcdic is the most frequently used code in synchronous environments.

There are other 8-bit codes used by computer manufacturers, but with a major swing toward 3270 compatibility, Ebcdic is becoming the de facto standard.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Protocol refers to the rules that both the sender and the receiver use. These prearranged standards are thoroughly understood by the devices at each end. The protocol is essentially a standardized use of certain characters for control of the communications procedure and of error-handling rules. Chaos would prevail without such rules and standards.

The protocol used by asynchronous devices is typically indicated by specifying which terminal is to be emulated. TWX or telex terminals using Ascii code are most common.

An increasing number of devices can transmit whole screens of information or blocks of stored information at one time — but in asynchronous mode. Ascii code is used, but some of the control characters are used differently. There are several variations of this, such as block mode, VT100 compatibility or IBM 3101 compatibility. Because minicomputers have tended to be asynchronous-oriented and because DEC sets the industry pattern, DEC's VT100 is the de facto standard. Three protocols dominate synchronous communications; none are identified with a specific terminal.

Binary Synchronous Communictions (BSC) is the oldest and most widely used protocol. Introduced by IBM in 1966, BSC is an out-of-date, inefficient line protocol. There are thousands of users, however, who are not willing to throw out equipment that is still productive just because IBM is pushing Systems Network Architecture (SNA).

SNA uses the Synchronous Data Link Control (SDLC) protocol. Although SDLC is a more modern and efficient protocol, widespread use did not begin until about 1980-81. Most new communications devices in the IBM environment use SDLC.

High-Level Data Link Control (HDLC) is a widely accepted international standard line protocol. HDLC is the protocol used within the X.25 packet interface. SDLC is considered a subset of HDLC. Most manufacturers, not wanting just to follow IBM, are implementing communications systems using HDLC.

How does a personal computer or terminal connect to a modem? What does the plug look like? What electrical signals are used? What do specific signals mean? To facilitate use of different modems with different data devices, standard physical interfaces have been defined and accepted. For data communications, the most widely used interface is RS-232C. Internationally, this is known as V.24-V.28.

Other interfaces include RS-449 and V.35. Local-area network attachments fall into this broad category, although different modes and protocols are used. Therefore, Xerox Corp.'s Ethernet or Corvus Systems, Inc.'s Omninet would be considered external interface definitions.

How are personal computers actually used? In order for any personal computer to communicate with another device, hardware must provide the physical/electrical interface and the timing/sending/receiving capability, and software must implement the protocol and handle the codes where necessary. In synchronous communications, the handling of the protocol is usually included in the implementation of the hardware on the communications board. Only the code and its meaning are handled by software.

The simplest application is for a personal computer to emulate an Ascii terminal — operating asynchronously and line by line like a telex teleprinter. Speeds can vary from 110 bit/sec to 9,600 bit/sec, with 300 bit/sec

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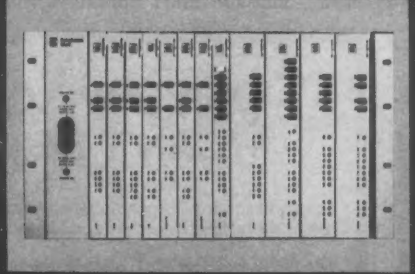

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WHICH IS THE FAIREST TERMINAL OF ALL?

and 1,200 bit/sec the most commonly used. For 300 bit/sec, a Bell 103-compatible modem is used, and for 1,200 bit/sec, a Bell 212-compatible modem is most often used. In this application environment, the micro uses little of its power, but for the price of an interface board and some software, an inexpensive terminal capability is achieved.

The next step is to emulate the more expensive editing terminals that transmit a screen of data at a time — a block of data — rather than just a character at a time. These devices run up to 9,600 bit/sec, but usually at 2,400 bit/sec or 4,800 bit/sec over phone lines. If the distance between the computer and the terminal is only a few hundred feet, modems may not be required; the interface cables can be connected using a simple bridging connector. For dial-up communications, 2,400 bit/sec is frequently used.

Above 1,200 bit/sec, most modems can provide clocking. It is necessary to determine what provides the clocking signals — the modems or the devices. When modems are used, they must match. Modems of the same type and the same manufacturer must be used at each end of the line.

The batch or remote job entry application grew out of the need to use large centralized computers from remote locations. Entire applications, including programs and data to be processed, were often submitted from a distant location. After the processing occurred, the results were transmitted to the remote site. The IBM terminals from which the jobs were sent and which later received and printed the results were the 2780 and 3780. Both are BSC devices, although the 3780 can be upgraded for SDLC.

This application is used to send files of data from one computer to another. It is not used for interactive computing: Data being sent or received is not displayed on the screen of the personal computer.

For the last few years, computer vendors have been scrambling to get into the IBM environment by providing 3270 compatibility. Today, this phenomenon is taking place in the personal computer marketplace.

But what is the 3270? There is no individual IBM product with the numeric designation 3270. Rather, the 3270 Information Display System is a family of devices that was introduced in 1972. This requires an explanation, but is necessary for an understanding of 3270 compatibility.

The 3270 Information Display System consists of three different types of equipment control units, displays and printers. There are two generations of these devices and several models of each type of device. Displays and printers connect to control units via coaxial cable, one device per cable. Control units are either local — they attach to the channel of a computer — or remote — they attach to a modem somewhere away from the computer room. Only the remote units will be addressed.

The remote units include the 3274, which has various models for both local and remote operation. Furthermore, the remote versions control different numbers of displays or printers — from 12 to 32. The 3274 can handle the color and graphics capabilities of the 3279. The 3276 is a combined control unit and 3278 display that can also control seven additional displays and printers, but cannot handle the graphics and full color of the 3279. In addition, both the 3274 and 3276 can operate in BSC or SNA/SDLC protocols, although some features require the SNA/SDLC versions of the 3274.

There are several display models. These define the number of 80-char. lines on a display (Model 1 has 12 lines, Model 2 has 24, Model 3 has 32 and Model 4 has 43) or the number of characters (Model 5 has 132 characters by 27 lines). To confuse matters more, the 3278 and 3279 displays cannot connect to the older 3271 and 3272 control units, but 3274s can handle a limited number of the older 3277 displays.

The result is a bewildering number of possible combinations and installed configurations. In most cases, 3274s have eight or more displays attached, while the 3276 operates with an average of three to four displays.

So what *is* 3270 compatibility? Most computer vendors have only recently gone beyond offering 3271/3277 compatibility. Today, an increasing number of SNA/SDLC 3274 implementations are becoming available, and 3276 emulation is also becoming available for personal computers. This means support of a stand-alone communications device — without enhanced color and graphics capabilities.

Furthermore, how does one know when full graphics and color capability is available? One knows by having it specified that a product is compatible with the 3274 Model 21C.

And how does one choose between BSC and SNA/SDLC? At the personal computer level, it does not matter much, except that SNA/SDLC capability is more expensive. The determining factor is what is available on the computer system with which the personal computer will communicate. If the host computer is not yet an SNA user, BSC should be used.

Note that previous discussion has addressed control unit compatibility. Furthermore, control units typically handle multiple devices. Replacing multiple 3278s with personal computers would require a modem for each micro and possible multiple circuits to replace existing facilities. What is needed is the capability for a personal computer to function as a display attached via coaxial cable to a 3274.

At least one company is providing this capability by supplying interface boards. They are available for the IBM Personal Computer and can be expected for Apple Computer, Inc., Texas Instruments, Inc. and other personal computers. The ability to replace displays and not just control units will allow personal computers to become a dominant force in office automation. Approximately one-half of all displays are attached to local control units. With 3278 compatibility, these can be replaced by personal computers without the need for new data communications facilities.

With over 1½ million 3270 display stations already installed around the world, there is a very large body of software written to support this popular family. But the size of the installed base and the investment in software already made means there will not be major changes in the protocols and terminal definitions. An investment made in 3270 compatibility, particularly 3278 or 3279 compatibility, will pay off for many years — even if IBM does upgrade the 3270 family.

Interconnecting devices with an Ethernet cable or through a private branch exchange (PBX) may not mean data communications to some. There are no modems or common carrier facilities, but it is communicating. Through the PBX, the interfaces, protocols and modes discussed above can be used. For Ethernet and other local-area networks, there would usually be different interfaces, but not always. Some local networks use RS-232C interfaces; others use SDLC. But SDLC on a coaxial cable shared by 50 other personal computers does not imply compatibility with the host as a 3270 or 3780.

As personal computers evolve into multifunction workstations, they will acquire voice processing capability. The new TI personal computer has integrated voice processing features. Can voice and data share the same communications facilities? Today, probably not. Different interfaces are required. In the future, particularly when voice facilities become digital, it will become standard procedure. ■

John King is vice-president of the DMW Group, a consulting firm in Ann Arbor, Mich.

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COST-EFFECTIVE TELECOMMUNICATIONS MANAGEMENT

BY BOB KAUFMAN

The first telecommunications explosion was ushered in by the words, "Mr. Watson, come here, I want you."

Almost one hundred years later, on June 26, 1968, the Federal Communications Commission released its decision with respect to the "Carterfone Case." Heralded by the word "competition," the second telecommunications explosion was launched. A century of monopolistic control over such a critical industry had finally come to an end. What was simple and basic twenty years ago has now become complex.

Prior to "Carterfone," the telephone bill was taken for granted. You called your telephone company, ordered lines and equipment and paid the bill from month to month. Like the electric and water bills, it was paid to the penny and rarely questioned. In essence, it was unmanageable. Why? Because no one in your organization knew how to manage it. Today, if you do nothing about managing your telephone expenses, you may not be getting the best value for your money.

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Honeywell's DSA establishes standards for data movement and application cooperation in compliance with the International Standards Organization's (ISO) open systems reference model. The architecture, which is not dependent on specific technology or techniques, keeps applications and communication processes separate. Thus DSA is transparent to the end user. DSA creates a cooperative, flexible environment within which the user can build and phase in a communications system that can handle current applications and grow to meet new domestic and international demands.

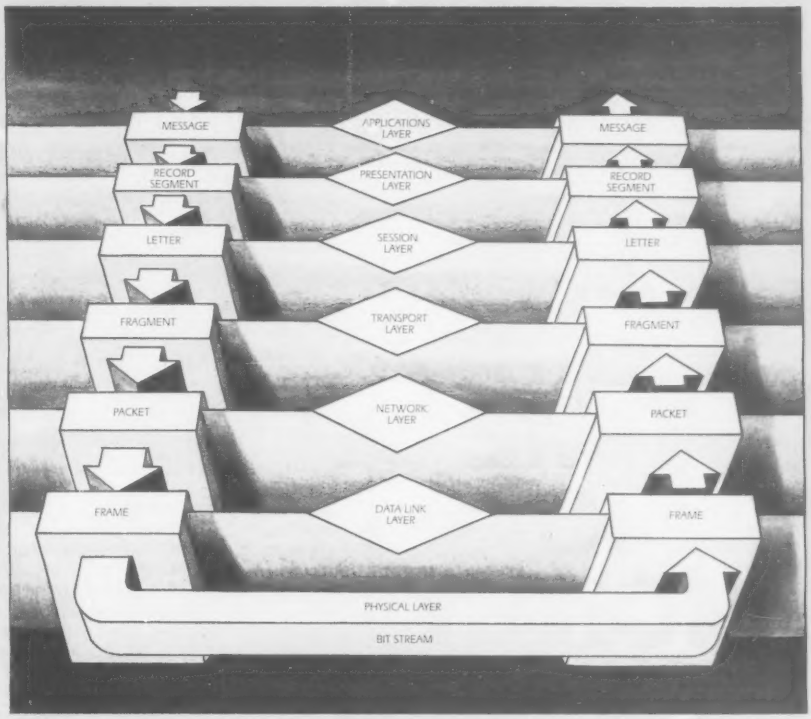
DSA Structure

DSA's flexible set of rules, protocols, and interfaces allows users to configure and implement data processing systems and networks to help meet the needs of geographically dispersed organizations. Introduced in 1980, DSA consists of a seven layer architecture divided into three groups. The implementation of the first four layers in the Communications Management group controls physical exchanges across the network. The next two layers, the Message Management group, format messages so that the communicating entities can understand each other. They also contain the dialog mechanism that permits communicating activities to synchronize their actions, and the presentation control services which provide application independence from data format, character codes, and terminal handling conventions. The seventh layer, Applications, defines the logical rules to which computer applications conform when communicating. Finally, each layer of DSA also provides network administration and control data to enable overall network control of the distributed system.

Network Support

Because DSA conforms to the ISO open systems model, it's certified as providing native support for the CCITT international X.25 packet-switched and X.21 circuit-switched network protocols. These protocols are being implemented in a growing list of public data networks around the world as well as in value-added and private networks. DSA products support such X.25 based networks as TELENET and TYMNET (United States), DATAPAC (Canada), DATEX-P (Germany, Austria), DDX-P (Japan), DN 1 (The Netherlands), EURONET (European Economic Community), PSS (United Kingdom), EDWP (Switzerland), and TRANSPAC (France). Also supported is the X.21-based NORDIC Net (Scandinavia, Finland). DSA uses High-level Data Link Control (HDLC), also an ISO standard, for data communications between intelligent devices in private networks. Users can configure hierarchical, peer-coupled and hybrid network topologies.

Product Implementation
DSA already enables medium-scale and large-scale host computers and mini-computers to operate in a variety of network configurations. Specialized network processors can be utilized for front-end processing, remote concentration and switching, in addition to communications control and administrative functions. The implementation includes such distributed processing applications as file transfer, remote job entry, terminal concentration and two-level transaction processing as well as office automation applications, including document distribution and host storage, and printing of documents. In addition, DSA administration permits monitoring, control, and maintenance of the network from one or more control sites.



DSA consists of seven layers of functions and protocols governing data handling among network nodes. DSA's implementation of the bottom four layers makes physical exchanges across the network transparent to the end user.

Future Growth
DSA is an important part of Honeywell's implementation of its Distributed Systems Environment (DSE). Future DSA developments will support fully-distributed transaction processing with system-supplied coordination, control, and recovery, load leveling, and resource sharing across computers. This type of peer network will allow host and satellite processors to cooperate as full equals in distributed systems. The open architecture will be further enhanced to meet evolving international network standards while protecting investments in systems already installed. Additionally, data bases will be partitioned across multiple processors with automatic access and updates at all locations. Thus DSA is part of an evolution to fully distributed systems with globally accessible resources.

More on Distributed Processing Networks
For an in-depth description of the DSA open architecture call our toll free number, 800-343-6294 (in Massachusetts call 617-895-7572) or write Honeywell, 200 Smith Street (MS 440), Waltham, Massachusetts 02154.

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COST-EFFECTIVE TELECOMMUNICATIONS MANAGEMENT

worth, take the following self-assessment quiz:

1. If you never review the telephone bill and just pay what is indicated, give yourself no points. If you review the bill, give yourself one point.

2. If you know your telephone expenses are going up, going down or remaining the same, give yourself one point.

3. If your telephone expenses are going down, give yourself one point.

4. If you have seen your telephone company representative within the last year, give yourself one point.

5. If you have seen or spoken to a representative from one of the other common carriers, give yourself one point.

6. If you know what your telephone company-provided equipment is costing you, give yourself one point.

7. If you have requested formal proposals for improving your present telephone system within the last three years, give yourself one point.

8. If you have considered obtaining (leasing, renting or buying) your telephone equipment from a party other than the telephone company, give yourself one point.

9. If you have considered such services as Wats, foreign exchange, remote call forwarding or others, give yourself one point.

10. And finally, if it was your idea to read this article, give yourself one point.

If your score on the self-assessment quiz was 10, then you are headed in the right direction if you want to lower your telephone costs. If your score is 7 or greater, you are concerned about your telephone expenses. But if your score is 6 or less, you probably do not even know what your telephone expenses are. If you want to control your telephone expenses and turn those costs into profits, you must be able to manage them, just like you manage people.

Cost-effective telecommunications management is a structured approach toward turning telephone costs into profits. Industry experts state that 15% of every telephone bill is fat. Studies have shown that U.S. industry is wasting $3 billion to $4 billion a year on the telephone. But who really cares about U.S. industry? All you should care about is the telephone expenses in your organization. Let the other guys waste *their* money.

Telephone costs are incurred in five major areas:

- Basic service and equipment.
- Local message unit calling.
- Long-distance calling.
- Operator-assisted calling.
- Other charges and credits.

Each area is unique and requires its own analytical technique and alternatives treatment.

You should never have a problem locating the costs associated with this area — it is always the first line on the bill. It is often referred to as "Service and Equipment"; however, many telephone companies are now using the term "Monthly Charges" or "Basic Monthly Charges." Sometimes other charges that are not really basic service are included in this cost area. For example, the initial fee for Wats, which is by no means a basic service, may be included in the first line of the bill.

Many times the basic service and equipment costs are a hodgepodge of monthly recurring charges. It is unfortunate that basic service is bundled with equipment, since these are two distinct and different items. However, they do have one thing in common: They are essential to telephone service. Some type of line and some type of telephone is needed.

The total charges in this document should be equal to the first line on the monthly bill. If they are not, you have a problem. You can request a copy of the service and equipment record from your telephone company representative or business office.

Message unit calling is becoming a fact of life in almost every major metropolitan area in the country. The concept of unlimited local calling is rapidly coming to an end as more and more telephone companies adopt message unit calling. Many of the major cities have had message unit calling for over 25 years. If you are located in an area that does not have this service, you have one less area of cost to worry about. However, for users, message unit calling will probably be the second largest contributor to the total telephone cost.

Under message unit calling, you are essentially charged for each call made. When you subscribe to measured rate basic service, you are entitled to an allotment of so many units. For example, basic service for one measured business line may cost $20/mo. The first 60 message units are included in the service. If you use more than the 60, you will be charged for each additional message unit. After your initial allotment is used, message units may cost anywhere from 4 cents to 25 cents each, depending on local telephone company rates.

Reducing the costs associated with message unit calling is not an easy task. It requires analysis (which is a specialty all its own), implementing possible alternatives and developing and enforcing management policies. This is an important area with rapidly rising costs. In the metropolitan New York area, New York Telephone has implemented reduced rate message units for calls made in the evening. Analysis in this area will become complex in the next few years as message unit calling contributes to a larger portion of telephone expenses.

Since the first long-distance call was made in 1881 between Boston and Providence, several trillion telephone calls have been made, most by businesses. It is no concealed fact that businesses, through the use of heavy long-distance calling, have enabled telephone companies to provide and operate intercity toll facilities. Businesses continue to account for most of the telephone company's long-distance revenue.

For years, businesses have subsidized costs associated with providing basic and long-distance services to private residences. For several years, telephone companies have had enormous advertising campaigns to encourage residence customers (as opposed to business customers) to make long-distance or toll calls. For most business users, long-distance calling will account for the largest percentage of telephone costs. Because of its cost magnitude, this area is usually attacked first. Often it yields the most dollar savings or contribution to profit.

Long-distance toll calling is probably the most mismanaged cost area, despite the numerous alternatives available. Long-distance, direct-dial toll calls are usually reported under the long-distance section of your monthly telephone bill. Many telephone companies refer to this section as "Itemized Calls." It is a mishmash of long-distance, direct-dial calls (the third area of cost reduction) and other calls such as credit card, operator-assisted, person-to-person, collect, directory assistance and telegrams, to mention only a few. Number called, date of call, duration of call, time of call and applicable discount are shown for each call made.

Toll calling is only one way of making long-distance calls. There are many alternatives that allow the same call at a lesser rate. Many of these alternatives are referred to as "Bulk Services," the most common being Wats. Many users may be placing long-distance calls using Wats, Foreign Exchange, Metro Service or some other type of bulk service. In most cases, you will receive no detail about any of the long-distance calls made on these bulk services.

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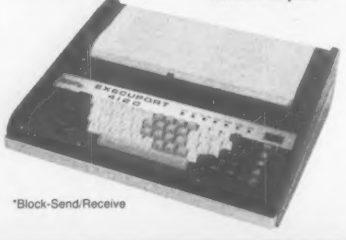

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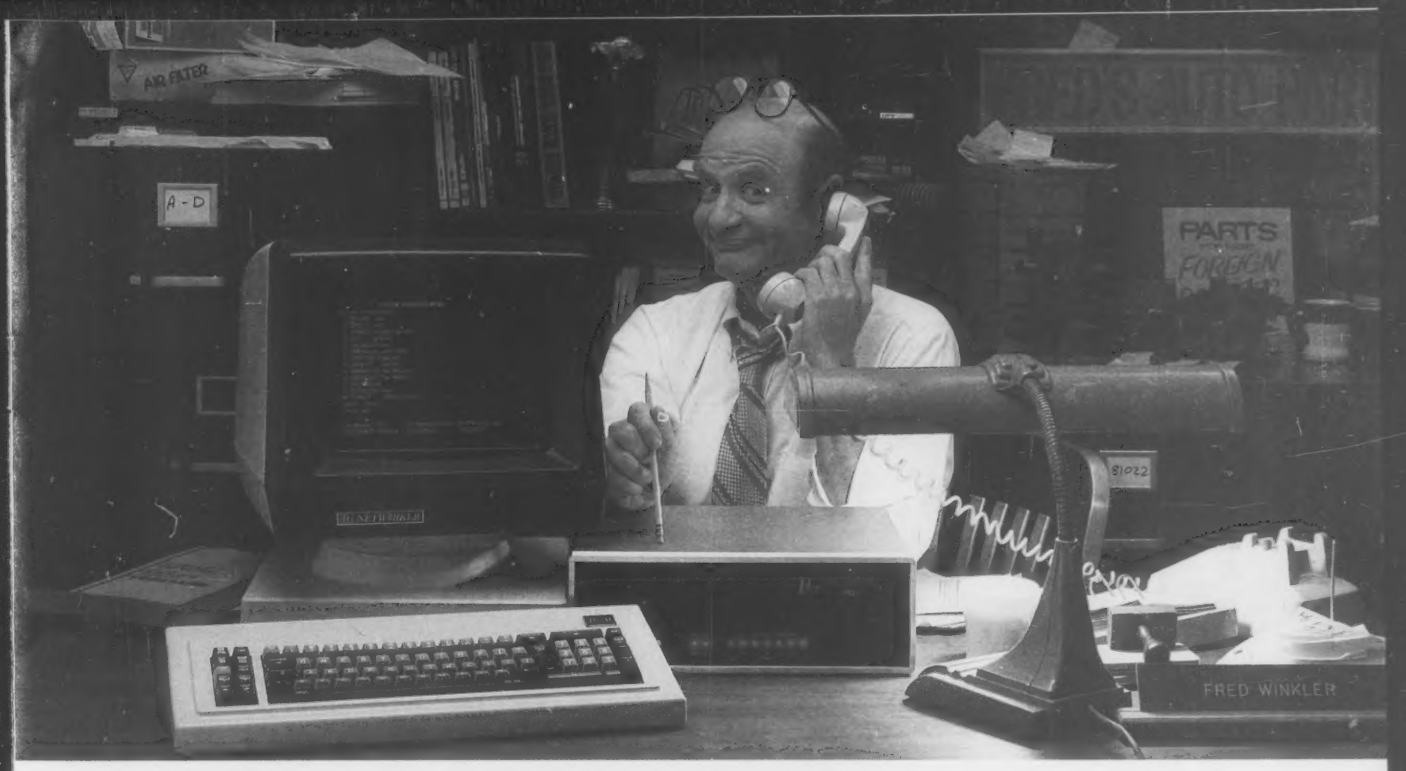

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long-distance calls and must be scrutinized. Fortunately, there are ways to analyze them. Computerized Wats tapes are available from many telephone companies for a nominal fee. These tapes contain data on long-distance calls, such as number called, day and duration of call and so forth.

Many long-distance calls can now be made using the specialized common carriers instead of the Bell system. These carriers provide alternatives to other forms of bulk services and long-distance toll calling. Long-distance calls made via the specialized common carriers are included in the long-distance calling cost area. Specialized common carriers also supply detailed information on each long-distance call. Some carriers provide an analysis or summary of calling patterns and charges.

The fourth cost area, "Operator-Assisted Calling," is a class unto itself. It is partly responsible for inward long-distance calling — collect calls and a host of other long-distance calls that require the assistance of an operator, such as credit card calls and person-to-person calls. Operator-assisted calls are usually billed under the "Itemized" or "Long-Distance" section of the bill.

Many telephone companies indicate operator-assisted calls with a special symbol. In this way, these calls are easily recognized. Operator-assisted calls are special because they cost several times more than a direct-dial, station-to-station call. For example, a one-minute, operator-assisted call from Boston to Seattle (day rate) would cost $2.29, while a direct-dial (no operator required) call would cost 74 cents. There are many alternatives to the various types of operator-assisted calls.

Inward collect calling is probably the largest percentage, with respect to cost, of the whole gamut of operator-assisted calls. Telephone companies recognized this about 20 years ago and developed the concept of Inwats. Toll-free calling, as Inwats is sometimes called, allows the called party, rather than the calling party, to pay the charges. Calls are dialed directly to an 800 number instead of to an operator.

The final and fifth cost area is "Other Charges and Credits." Most of the time this will be other charges. Credits are rarely seen, except when service or equipment is discontinued. You will receive credits when you discontinue service because most telephone companies bill their basic service and equipment in advance.

The bulk of the charges occurring in this cost area will be for moves, changes and installation fees, which usually run about 5% of your total bill. Charges can be much higher when circuits are rearranged or departments moved within organizational facilities. Other charges may include directory advertising, telegrams and surcharges.

Depending on your location, taxes can mean an extra bonus when you reduce telephone costs. On many telephone bills, state taxes as well as municipal or county taxes have been added to the total amount of the bill. In some locations, the effective tax rate (all taxes combined) can be as much as 20%. Therefore, every dollar you save is really worth about $1.20. Keep this in mind when evaluating various alternatives — the savings realized may be much higher than anticipated.

It is important that you understand the five basic areas of cost reduction. You should be able to determine the contribution each one of the five areas makes to the total telephone expenses. Percentages vary from industry to industry. Hospitals may have rather heavy basic service and equipment costs and very little long-distance calling. On the other hand, a nationwide market research firm may have predominantly long-distance calling.

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seasonal fluctuations, the cost of each of the five major areas will be consistent on a month-to-month basis. However, it is advisable to perform a 24-month study to reveal possible seasonal fluctuations and monthly exceptions such as plant shutdowns and so forth.

Once you know where your costs lie and the percentage contribution of each, you are ready to begin the cost-reduction effort. The following are several key points to remember:

- Telephone expenses can be classified into five different areas.
- Basic service and equipment costs are itemized on a service and equipment record obtainable from the telephone company. The components of this charge are not usually listed on your monthly bill.
- Message unit calling will probably be the second largest contributor to the total cost of your telephone resources.
- Long-distance toll calling may very well be the most mismanaged cost area. It often yields the most dollar savings.
- Operator-assisted telephone calls are special because they are more expensive than a direct-dial, station-to-station call.
- Miscellaneous fees for moves and changes are itemized on your other charges and credits statement.

A good starting point is essential in the cost-reduction process. First, locate your telephone bills for the last 12 months. Perform an analysis and plot a three-month moving average of your telephone expenses against your net sales. It is wise to use a three-month moving average in order to smooth out any major irregularities in your monthly telephone bill due to payment schedule. A good practice is always to plot the net sales, since in most businesses, net sales do track telephone expenses — that is, higher sales usually track higher telephone expenses.

After plotting your three-month moving average of telephone costs and net sales, you should be able to determine if your telephone costs are moving up, down or remaining the same. In addition, you will be able to determine if there are any seasonal variations that may affect your telephone expenses. Remember that a downward or upward movement of your net sales and telephone expenses means that a variation has occurred, possibly two to three months before the actual indication on the three-month moving average.

If telephone expenses are rising and net sales are also rising, there is little cause to be concerned. Of course, it is better if telephone expenses are going down and net sales going up. However, if your sales are going down and your telephone expenses rising, you should be concerned.

Next, see if you can determine the five areas of cost reduction for each telephone bill. You should be able to quantify the five areas. Three months of billing information should suffice to compute the percentage contribution of each of the five areas to your monthly telephone expenses. There should be some consistency among the figures.

At this time, you should be able to determine your largest potential area for cost reduction. Approach this area first, unless you are convinced that you can reduce costs in other areas by some alternative means and save more money by attacking the largest contributor to cost first.

It is physically impossible to evaluate every alternative. It is wise to call in telephone companies, vendors and the specialized common carriers to get their views on how to approach your specific cost-reduction problem. Also remember that level of service must be taken into account. One Wats, Foreign Exchange or other

such line may not be able to carry your traffic. You may want to consult some of the many books on this topic or one of the reputable telephone consultants in your locale.

Do not try to be a hero all at once. Many times, several new cost-saving ideas are implemented all at once, creating several problems. Results cannot be measured since several alternatives may shadow each other. In addition, users may not be able to adjust and may be thrown into shell shock over the cost-reduction alternatives. It is best to perform a phased-in, gradual approach in the total cost-reduction effort.

Over a period of six months or a year, your total telephone expenses will go down dramatically. From a management view, a phased-in approach buys credibility with management and shows that you know what you are doing. As management sees the cost-reduction effort starting to pay off, it will be easier to obtain management's blessing for implementing other cost-saving alternatives.

Managing your telephone expenses is like managing any other aspect of your business. Someone in your organization, perhaps the controller or vice-president of finance, must be given responsibility for the control of telephone expenses. In addition, authority to implement changes must be delegated with this responsibility. One person in your organization must be solely accountable and responsible for controlling telephone expenses. This person must review telephone bills, perform telephone audits, constantly plot three-month moving averages and implement all cost-saving alternatives. It is not an easy task.

In a large organization, first- and second-line managers must also be held accountable for the telephone expenses through budget variance reporting. Realistic budgets should be developed by department managers with estimates of the telephone expenses they will incur. If for some reason telephone expenses rise by above 10%, an analysis should be performed to determine the cause.

In addition to standard management controls and procedures to ensure compliance with budgeted targets, management and employees must be educated in the cost-reduction effort. Why do some managers' calls last an average of 30 minutes and others' only five minutes? Would they spend as much time on the telephone if it was their own money? An entire education process involving the use of meetings, posters and perhaps a rebate or profit-sharing plan to encourage telephone cost-reduction techniques should be considered. Many companies try to encourage making telephone calls outside the peak busy hours so that lines are not overloaded and fewer lines are utilized. This is done by charging departments only 10% of the call instead of 100% if the call is made prior to 10 a.m. or after 6 p.m. Other techniques are also available.

Well, there you have it. You can pick up a pencil now, pull out those old telephone bills and start the analysis. You can forget what you have learned and let your telephone bills continue to rise, or you can start to lower them right now. Give it a chance — implement one alternative and see what happens. If your efforts bear fruit, continue implementing more alternatives. As you reduce costs, you will realize that telephone expenses can be controlled and managed.

Start now, because for every month that goes by, you could have added profits to the bottom line of your organization's profit statement. ■

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Kaufman is president of National Telecom Services, Inc. in Needham, Mass.

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MODEMS

BY ROGER S. PETERSON

At the turn of the century, a business was considered modern and established if it had one telephone for its few employees whose duties required outside calls. Today, every workstation has a telephone system terminal that does everything but make coffee for the office of the future. Similarly, employee computer access has passed the era of the big company mainframe with its long queue of eager users. There is a micro at each workstation, creating an expanded role for corporate communications through computers and telephone lines. This requires modems. A simple modem used to be sufficient — but not anymore.

Data communications and electronic mail are widely regarded as the big growth areas for the '80s. Modems play an integral part in corporate communications. Modem technology has passed through several generations. A wide selection exists to solve business data communications problems. Choosing the right modem can be facilitated by briefly reviewing the ▶

generations of modems and their differences and by spotlighting typical communications needs.

Before 1968, only Bell system-supplied equipment or acoustically coupled modems were available. Data communications and electronic mail existed and operated within the rules of the telephone industry, and their growth and versatility were greatly hampered by telephone tariff restrictions. Data could reach out and touch someone, but it had to do it Ma Bell's way.

Data communications received a boost on June 26, 1968, when the Federal Communications Commission (FCC) laid down its Carterfone Decision. This decision opened the way for direct interconnection of non-Bell devices to the Bell telephone network. Data communications applications grew, even though the FCC permitted the telephone company to protect its networks.

This was done through Data Access Arrangements, which the Bell system supplied from 1969 to 1977. These arrangements permitted non-Bell equipment to connect properly to the telephone network. In a significant way, this new flexibility in data communications linkage accelerated the influence of computers and data processing in our personal and professional lives. It also led to a greater variety of modems to suit various business applications.

Another change occurred in 1977. FCC rules permitted manufacturers to develop their own protective circuitry, thus replacing Bell's Data Access Arrangements. Manufacturers then integrated their protective circuitry into their modems so end users could connect the modem directly to the telephone line. This step further loosened Bell's control of telecommunications and modem equipment, serving as an additional incentive to enterprising manufacturers.

In the past, if you had seen one modem, you had seen them all. The '80s ended that: Enter the microprocessor-based modem. The modem no longer simply performs its original task of go-between or translator between a telephone's analog circuits and the computer's digital essence. With a host computer and an appropriate terminal program or communications software package, intelligent modems automatically perform functions that previously required the user's manual operation.

In the past, if you had seen one modem, you had seen them all. The '80s ended that: Enter the microprocessor-based modem. The modem no longer simply performs its original task of go-between or translator.

For a nontechnical person, entering the world of modems can be more confusing than an initial walk into a personal computer dealership. But there is a yellow brick road. Modems differ according to these generic areas: transmission speed through telephone lines; distance between intended sites of communications linkage; transmission direction — one-way or two-way; type of connection — for example, how a telephone physically interfaces with the modem; and the attention/independence factor — for example, do you need a modem capable of operating regardless of what the host computer or its human operator is doing? With these generic categories in mind, the technical nuances can be put into a friendlier frame of reference.

Distance can be the main criterion for selecting a modem. If an application or business network is less than 50 miles long, a short-haul modem can be used. Avanti Communications Corp. has a modem for data transmissions of 1,000 feet to six miles. These short-haul modems are less expensive and operate at high speeds, specifically, 2,000 to 9,000 bit/sec.

If short-distance communications is not a factor, a voice-grade or voiceband modem is needed, so labeled because it operates on telephone lines. Sending data over telephone lines is not foolproof; it requires fast transmission rates and expensive technology, especially at 1,200 bit/sec. More sophisticated modems have the ability to detect whether data has been garbled in transmission and can resend the characters automatically.

Nevertheless, telephone lines are an imperfect carrier. A further way of avoiding telephone line garbling is to subscribe to a communications network composed of local telephone numbers that access data-grade lines. Such networks provide a message store-and-forward service for the customer's computer system.

Distance and speed are related and are important criteria for selecting a modem. If you develop your own private local-area network, an inexpensive modem can be used to transmit data quickly. Such a private network, however, is expensive. This cost can be avoided by using the network already nearby in the telephone lines, but the transmission rate slows to 300 and 4,800 bit/sec, and, occasionally, transmission is garbled. In spite of these shortcomings, it is necessary to remember that the telephone network is always nearby and that many modems are portable.

There are two types of connections: acoustic and direct connect. Acoustic modems have a receiver-shaped cradle into which the receiver is placed for data transmission. Acoustic modems have an advantage over direct connect in that they can be used anywhere — telephone booths, hotel rooms and so on. Place the receiver in the cradle and you are ready to transmit. Traveling business people, especially sales representatives, find this feature important. Direct-connect modems use the familiar modular inserts found in newly installed telephones, bypassing the role of the telephone receiver. The modem is plugged directly into the telephone wall jack. The advantage of direct connect is that extraneous outside noise cannot creep into data transmissions the way it can with acoustic modems. Even tightly matched telephone receivers and acoustic cradles permit some noise infection.

Direction of data transmission is an important consideration. Simplex, or one-way, communications involves simply transmitting data to a remote site without receiving data from the same site.

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The new Halcyon 4001 concentrates up to 16 channels over a single phone link. You get user-selected channel priority (high, low and normal), comprehensive network monitoring, statistics gathering and complete systems diagnostics. Its multiprocessor architecture gives you high throughput and fast echo response at speeds from 50 to 9600 b/s.

Or, for larger line loads, choose the Halcyon 4220. The 4220 Stat Mux has all the monitoring and diagnostic capability of the 4001, and much more. It gives you up to 60-channel capacity over one or two links with complete network control from a single, central location.

Operated from either the front panel or an external terminal, the 4220 offers all the capacity you need to ensure high-speed data transfer with future network expansion. You can also connect a printer for automatic hard-copy printout.

And of course, service is available worldwide.

For all the details on the Halcyon line of stat muxes, call TOLL FREE 1-800-854-7100, ext. 147, or in California, call 1-800-422-4241 ext. 147. Or write Halcyon, Inc., 2121 Zanker Road, San Jose, CA 95131.

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4220
STAT MUX

FEATURES

- ☐ Single or dual aggregate high-speed links up to 19.2 kb/s with automatic dynamic load sharing
- ☐ Dual control ports
- ☐ Tail-circuit capability
- ☐ Simple menu-driven programming
- ☐ Dynamic network security system

SPECIFICATIONS

Mechanical	
Height	7 in (17.8 cm)
Width	16.75 in (42.5 cm)
Depth	18.75 in (47.6 cm)
Weight	35 lbs (15.8 kg)
Environmental	
Temperature	0 to 50°C
Humidity	0 to 90%
Electrical	
Input voltage	120 or 230
Frequency	50–60 Hz
Power consumption	200 VA
EMI and RFI radiation	FCC requirement for Class B equipment
Link Interface	
Number and type	1 or 2, full duplex
Speeds	1 link up to 19.2 kb/s with other link as backup; 2 links up to 9600 b/s, with dynamic band sharing
Protocol	X.25 Level 2 (HDLC)
Transmission mode	Bit oriented, synchronous
Line Interface	
Number of Ports	60 (max, including asynchronous and synchronous)
Asynchronous ports	
Number and type	22 expandable to 60, full- or half-duplex
Speeds	50, 75, 110, 134.5, 150, 300, 1200 b/s (2400, 4800, or 9600 b/s on special order), or external clock
Codes	Any 5, 6, 7, or 8 bits per character, not including parity bit
Parity	Odd, even, or none
Stop bits	1, 1.5, or 2
Distortion	45% on input; 2% on output
Interfaces	RS-232-C/CCITT V.24; current loop 20, 40, or 60 mA, active or passive. The interfaces can be different at either end of a port.
EIA control signals passed per line	DSR, CTS, DCD, RI, DTR, RTS, pins 11 and 25
Autobaud speeds	110 to 9600 b/s
Autobaud preamble characters	Memorex autobaud characters or two carriage returns
Flow and buffer control	XON/XOFF or any EIA; mixed control at either end
Synchronous ports	
Number	16 (max)
Speeds	1200, 2400, 4800, 7200 and 9600 b/s
Protocols	IBM 3270, 2780/3780, CDC 200 UT, WANG
Codes	EBCDIC, ASCII, and two user-defined codes
Interface	RS-232-C/CCITT V.24
EIA control signal passed per line	DSR, CTS, DCD, RI, DTR, RTS, pins 11 and 25
Control ports	Any 1 asynchronous ASCII port
Monitor ports	Through 2 asynchronous line ports
Line diagnostics	Operator- and user-controlled loopback and test
Link diagnostics	Operator-controlled loopback and test
System Statistics	Through any 1 asynchronous ASCII port. Output to printer will consist of ERROR, EIA, and Critical Data Statistics at link, port, and node levels

4001
STAT MUX

FEATURES

- ☐ Programmable Echoplex per channel per end
- ☐ Programmable security for controlled front panel access
- ☐ Continuous monitoring of system status and channel signal and data activity through front panel display
- ☐ Each unit upgradeable in 4-port increments

SPECIFICATIONS

Mechanical	
Height	3.25 in (8.3 cm)
Width	14.12 in (35.9 cm)
Depth	10.5 in (26.7 cm)
Weight	8.9 lbs (4.0 kg)
Environmental	
Temperature	0° to 50°C
Humidity	0 to 90%
Electrical	
Input voltage	115 or 220/240 ±10%
Frequency	47–63 Hz
Front panel	
	Eight character alphanumeric display 10-key touch pad 12 LEDs for network status
Line Interface	
Number of Ports	4, 8, 12, or 16
Interface connectors	Female 25-pin EIA
Protocol	Asynchronous
Number and type	Up to 16, full- and half-duplex
Speeds*	50, 75, 110, 134.5, 150, 200, 300, 600, and 1200 b/s (or external clock**); 1800, 2400, 3600, 4800, 7200, and 9600 b/s optional
Codes	Any 5, 6, 7, or 8 bits per character
Parity	Odd, even, or none
Stop bits	1, 1.5, or 2
Interface	RS-232-C/CCITT V.24
EIA control signals passed per line	4 pins each direction
Autobaud speeds	1200, 600, 300, 200, 150, and 110 b/s
Autobaud preamble characters	Carriage return
Flow and buffer control	XON/XOFF, DSR/DTR, CTS/RTS, and T-Pause
Echoplex	Selectable per channel per end

*Any line may use a different speed at each end.

**External clocking only on second board (4 line) interface; i.e., no external clocking on four channel unit.

Link Interface	
Number and type	1 full duplex
Speed	Up to 9600 b/s synchronous or NRZI asynchronous
Protocol	X.25 Level 2
Interface	RS-232-C/CCITT V.24
Line diagnostics	Operator- and user-controlled loopback and/or test and front panel monitoring
Link diagnostics	Operator-controlled loopback and/or test
Unauthorized access prevention	

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More often two-way communications is needed. There are two such modes: half duplex and full duplex. Half duplex permits transmission in both directions, but only one at a time. Full duplex enables both transmitters to send data simultaneously. Full-duplex transmission usually means a slower data rate and a more taxing demand on the telephone lines, but its simultaneous direction feature amounts to faster data transmission. Many Bell 103 series modems work in both full and half-duplex modes. This further expands the user's ability to adapt to the telephone network's weak spots or the receiving modem's limitations.

These generic differences among modems are important to consider when adding data communications to a system. Lately, however, the attention/independence factor has been in the spotlight. This is because a modem that works independently of its host — be it a personal computer or dumb terminal — does not tie up that host from other tasks. The user can still run other programs or the computer can be turned off. Likewise, a modem that can transmit data without a human operator's attention is a time-saver for office staff.

The new category of intelligent modems has this popular feature. Microprocessor-based with onboard, random-access memory (RAM), the intelligent modem uses a clock/calendar to send automatically messages stored in the RAM at times prescribed by the operator. Such a unit is a modem "plus." Some users view this as a modem with intelligence, memory and clock/calendar, while others see it as a sophisticated electronic mail device priced barely above most modems. The essential point is that this new class of modem goes beyond old modem boundaries.

But what was around before them? Basically, there are two lower levels of modem sophistication. One is the simple modem that simply translates digital data through analog telephone circuits. The other is a middle-range modem with more capabilities than simple modems but without the sophistication and automation of new intelligent modems.

If the modem is needed merely to use telephone lines to access other computers or services, Radio Shack offers four units, two in the simple modem category and two in the middle-range group. The least expensive is an acoustic coupler running at 300 bit/sec, priced at $149. It is a Bell 103 series modem using the standard RS-232C interface. Because it is a fairly small acoustic modem, it is good for traveling businessmen. If travel portability is not essential, a direct-connect modem is available from Radio Shack for the same price.

Beyond these two simple modems, Radio Shack offers more power for $249 with a middle-range modem called Modem II. This modem has autoanswer and autodial and will hang up the telephone. This half-duplex model sends data at 300 bit/sec.

A more sophisticated modem is another middle-range type that Radio Shack calls the DC-1200, which transmits at both 300 and 1,200 bit/sec. This direct-connect modem is in permanent autoanswer, ready to receive messages if the host computer is properly configured. If the sending computer transmits at 300 bit/sec, the DC-1200 will receive the data at that rate. This unit operates at both half and full duplex and retails for $699. A $149 printed-circuit board accessory will add an automatic dial feature to the DC-1200, permitting the computer to operate unattended. Communications software is required.

Another modem with middle-range capability is the Hayes Stack configuration from Hayes Microcomputer Products, Inc. Clearly, this is the most sophisticated of the middle-range modems. The Stack components include a modem and a separate chronograph. There are two modems — the Smartmodem (300 bit/sec) and the Smartmodem 1200. Both are direct-connect modems operating at both full and half duplex. Each has seven LEDs on the front panel to indicate status of its autoanswer, carrier-detect, modem-ready, send-data and other states.

The Smartmodems can automatically answer the telephone, dial a number, receive and transmit data and then hang up the telephone. Adding the Hayes Chronograph provides the user with automatic time management

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for message transmission. Hayes also has an integrated printed-circuit board modem called the Micromodem II, which fits into an Apple Computer Inc. Apple II.

Although microprocessor-based, Hayes modems require the active attention and operation of the host computer or terminal: They are not independent of the host. To transmit data or access a network, the host must be dedicated solely to the modem. Also, the Hayes units have no internal RAM memory of their own for storing messages. The host's RAM and communications software are needed; this is the difference between the middle range of modems and the more sophisticated intelligent modems. The latter have on-board RAM and work independently of the host.

How does one operate an intelligent modem with the host computer? A communications software program that has a terminal mode and file transfer capabilities is needed. The operation process is simple.

First, turn on the host computer or terminal. Next, load the communications software or terminal program into the host machine. Third, go into the interactive mode between the host keyboard and the intelligent modem. If the communications software has file transfer capabilities, which are essential for uploading and downloading files from modem to host disk, this feature can be used to transfer a message or data from the host's disk to the modem for transmission over the lines.

Businesses that transmit a lot of data and that need to solve electronic mail problems are keenly interested in sophisticated modems. There is also an intense interest in using these devices to pull together the company's personal computers into one network.

In considering modems, several questions must be addressed. First of all, do you need to send data for three or more hours during each day? If the answer is yes, seriously consider leasing a private long-distance telephone line for data transmission. This lessens the chance for line quality irregularity and ensures line availability. The expense, however, is high.

[redacted] s transmission speed your only concern? If so, you may be overlooking features in some modems that can compensate for a lower communications speed. Again, remember the attention/independence factor and how it frees staff from handholding a modem during its operation.

Must data be transmitted in several small amounts throughout the day, regardless of time, or can you wait until day's end for data transmission? This is an important question. If you can wait until telephone rates are cheaper to send the data in a batch, cost savings can be substantial.

And with an intelligent modem with a clock/calendar, data can be sent automatically at 11:01 p.m. to cut telephone costs further. This kind of flexible scheduling makes intelligent modems useful.

Modem technology has had a metamorphosis of its own, sparked primarily by the loosening of the telephone industry's grips. In the future, modem changes could be prompted by revised CCITT regulations.

Technological advances could occur in firmware interaction with transmission rates and the modulation/demodulation function that modems perform for linked computers and telephone lines. Modem innovation and development will continue to expand modem capabilities beyond their original translator function. ■

Peterson is a consultant with Visionary Electronics, Inc. of San Francisco.

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A user who buys Racal-Vadic's new VA4840 modem, instead of renting a 208 from you, saves thousands of dollars in just a few short years. You see, Ma, the Racal-Vadic VA4840 has a payout of around 12 months and the monthly outlay is the same as renting. But renting from you is "forever."

Smaller, Too

In addition to costing far less than your 208, the VA4840 is smaller and has many more features and options. Look at its size, Ma. Eight VA4840 PC boards fit in Racal-Vadic's 10.5-inch-high rack-mount chassis. Up to 48 fit in a 7-foot rack cabinet, saving valuable space in central-computer sites. For remote-terminal use, the VA4840 comes in a single channel, desk-top cabinet.

Top Performance Over Unconditioned Lines

The VA4840 was designed for point-to-point or multipoint networks in which superior performance over normal unconditioned telephone lines is a must. The VA4840 uses an advanced automatic adaptive equalization system which enables the modem's receiver to instantly change filtering to compensate for variations in phase delay, amplitude roll-off, frequency offset, and carrier phase jitter. Our new 4800 bps modem features a built-in general purpose 8-bit microprocessor which controls a 16-bit multiplier and memory to perform all of the signal processing functions. This type of architecture greatly reduces the overhead and cost of the modem's design.

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The VA4840, like most Racal-Vadic modems, is FCC approved for direct connection to the switched network using programmable data jacks or a standard telephone jack. The VA4840 offers extensive diagnostics including Automatic Idle Test, Analog Loopback, Local and Remote Digital Loopback, and Self-Test.

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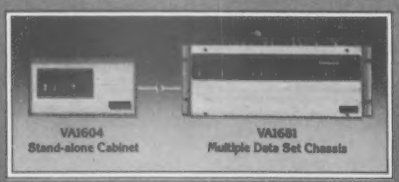

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NEW LOCAL LOOP SERVICES

By Bradley V. O'Brien

In the past, data communications systems have depended on voice networks for their transmission capabilities. For many years, the only form of data communications — other than telex — involved the use of a modem on the voice telephone network, switched▸

or dedicated. This is still the primary transmission vehicle for data communications, but many new forms of transmission have been developed in recent years.

The value-added network carriers, Bell Laboratories Dataphone Digital Service, the digital satellite carriers, digital microwave systems and others are all more easily and directly adaptable to data transmission.

One problem still remains for almost all of these new digital capabilities — the local loop to the user premises. This "last mile," as it has frequently been called, continues to be a limitation to new services, particularly digital and wideband digital services.

It is also an economic constraint, frequently costing one-third the total cost of a circuit. With the divestiture of the Bell local operating companies, the subsidy provided by the more profitable long-distance services will be removed from these local services, and their price can be expected to increase significantly over the next few years.

What changes, especially improvements, can users expect in the local loop situation over the next few years?

Many changes will occur, but most of them will stem from an unexpected source — the local telephone companies. More importantly, these changes will not be sudden. Satisfactory solutions to local loop problems will not be available soon, because the scope of the problem is too massive for the telephone companies and the competitors that will be offering alternative local loop solutions or bypass services.

There are many new services and technologies focusing on this problem. They include CATV, private microwave, digital termination service (DTS), FM radio sideband, cellular mobile radio and optical links.

The telephone companies are developing new technologies that enhance the digital carrying capacity of their copper wire distribution plants, and these enhancements will represent the major long-term improvements in the local loop situation.

Before discussing these alternatives and their respective applicability to data communications, it is necessary to examine the data communications applications impacted by the capabilities or lack of capabilities of local loops.

Two major categories of local-loop-related applications can be distinguished: long-distance communications access and local or intracity private networks.

Access lines connect a user's premises to the long-distance networks of the data service companies — either the value-added network carriers or the computer service companies with communications networks. In these cases, the driving force for change comes from the service vendor, not the user.

The service vendor is impacted economically by the local loop, but more importantly, he is impacted by his marketing efforts. His sales effort is impacted by the installation delays and by the presence of a third-party vendor between the service vendor and his customer. His new product offerings are affected by the limitations — primarily bandwidth — of the available local loop services.

Today, most service offerings of data service companies are oriented around voice-grade data lines. There is a growing need for higher bandwidth services such as computer-aided design and manufacturing and other graphics applications, high-speed file transfers between distributed processing systems and access to large data bases.

In addition, because of the huge increase in the number of workstations in all types of establishments, there is an economic need to pack the resulting cir-

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The Datamizer is an innovative new concept in data communications efficiency. It will *save you money* and improve performance from the very first day it's installed. The Datamizer is designed around an exclusive intelligent data compression algorithm that reduces repetitively transmitted characters into short length codes, and results in compression ratios of 2:1 or *better*. Since the Datamizer's output is fed directly into any standard communications modem, the effect of this compression is the immediate ability of any modem to operate at *double its rate*.

A high speed link
Utilizing any 9600 bps modem, the Datamizer can speed data communications up to 19,200 bps, over voice-grade or DDS lines, without expensive 14,400 and 16,000 bps modems—*error free*.

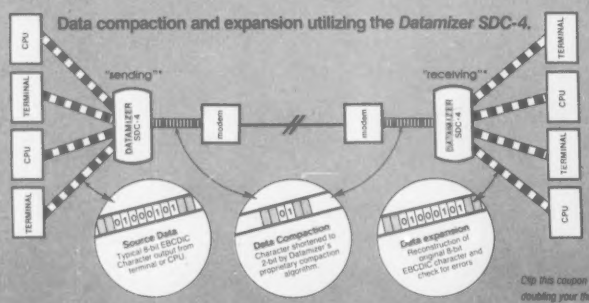
Cuts line charges in half
By doubling your throughput, the Datamizer immediately eliminates the need for redundant phone lines, saving significant line charges *every month*.

Plus, it's a MUX
The Datamizer SDC-4 is also an advanced 4 channel statistical multiplexer, capable of simultaneously muxing a different half or full-duplex communications protocol at an independent rate on *each channel*. Utilizing dynamic band width allocation, aggregate input of up to 38,400 bps is possible in certain configurations.

Hassle-free installation
Datamizers work in pairs, one on each end of a full duplex communications line. The units require no changes to your present equipment and no changes in protocol. All common async and synchronous protocols are supported, including bisync and HDLC. The Datamizers are simply installed between your terminal equipment and your existing modems.

The guarantee
At Symplex, we've built the Datamizer for outstanding performance and reliability. ***The Datamizer is guaranteed to provide double the data throughput, up to a full 19,200 bps.*** If the Datamizer fails to achieve this performance when used according to our published specifications, Symplex will provide a refund of the original purchase price. Write or call us for complete details of our guarantee.

Data compaction and expansion utilizing the *Datamizer SDC-4*.



This diagram illustrates data flow in only one direction. The Datamizer actually operates in full duplex.

Clip this coupon or call today and discover how the Datamizer SDC-4 can save you money by doubling your throughput—up to 19,200 bps.

Symplex Communications Corporation

Key Features
- Data compression 2:1 or better
- Built-in 4-channel statistical multiplexer
- Non-protocol dependent
- User transparent
- Full error detection and correction
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cuit requirements into multichannel and higher bandwidth circuits.

One effect of this growing vendor requirement for new local loop services is that many vendors will become more directly involved in the provision of local loop services. Many data service vendors have filed for DTS licenses. MCI Communications Corp. has established a relationship with a CATV company for cooperative local services, albeit for voice applications. Much of the impetus for new or bypass local circuit alternatives can be expected to come from the service vendors, both voice and data.

Another access line application is between a user location and a corporate private communications network. While many of the requirements and driving forces are the same in this case as they are for vendors, the situation is less clear because most of these corporate networks are primarily voice systems.

The other data application is local private networks, which fall into two categories. The first category, called branch office networks, is typified by banks and retail chains. Branch networks can be characterized as having a geographical distribution around a metropolitan area that approximates the distribution of population.

There are three distinct levels of communications networks among these local branch organizations, distinguished by volume of traffic. The smallest, exemplified by food chains, typically use only the dial telephone network for communications, both voice as well as data. The medium-volume operations, exemplified by branch banks, use multidrop lines with multiple branches on a single circuit. The largest, such as large department stores, usually have dedicated lines from the downtown headquarters location to each of the remote branches.

The other type of private local network is called a cluster network. It is typically a group of establishments that belong to the same parent company and are located within a short distance of each other. Most of the Fortune 1,300 companies have such clusters around their headquarters. Examples include the automobile companies around Detroit; IBM in Westchester County, N.Y.; General Electric Co. in Schenectady, N.Y.; and Westinghouse Electric Corp. around Pittsburgh, Pa. Most of these cluster networks grew out of a single location, often decades ago.

Many of the individual establishments in these clusters are large in terms of number of employees. As a result, the communications between the nodes of these clusters is often very large, and most of it is carried by dedicated lines.

In both branch and cluster networks, it is important to note that the bulk of the line requirements is generated by voice traffic. Usually the ratio is 20 to one, voice to data, except in the case of a corporate computer center or a research lab. With the geographic expansion of metropolitan areas, the continuing exodus of establishments to the suburbs, the rising importance of communications — particularly data communications in businesses — and the expected increase in local circuit rates, the intracity network market is an important one for these multiestablishment users.

Today, the only significant alternative to telephone company loops is private microwave. This alternative is attractive for large-volume users (multiple T-1 circuits). The major problem is the availability of spectrum, particularly in some of the largest cities. For smaller cities and for distant suburban locations, this is not a problem.

	Private Microwave				Coaxial		Fiber Optic Cable	Digital Terminal Service
	2 GHz	12 GHz	18 GHz	23 GHz	Private	CATV		
Range (Miles Without Repeaters)	25	12	7	5	10	10	5	6
Capacity (No. of VF's)	96	672	192	48	10,000 (theoretical)	24-96 (per TV channel)	1,000 (per pair of strands)	24
Availability	Scarce	Until 1988	OK	OK	Right of Way	Suburbs OK Downtown Scarce	Right of Way	12/City

Figure 1. Acceptance Criteria For ICCN Alternatives

Higher frequency systems (18 and 23 GHz) are now available and reliable if the distance is short enough — seven and four miles, respectively (see Figure 1). The lower frequencies are difficult to

There are two data communic

If you build your own data communications network, you have to maintain it yourself. And that means hours of planning, a big investment in capital equipment, dealing with vendors and the phone companies, providing ongoing testing and diagnostics, and making a lot of phone calls when a problem arises.

But RCA Cylix eliminates the hassles of building and managing your network. We supply you with the communications equipment and a satellite-based network, handle installation, and provide end-to-end management. And, if a problem ever does arise anywhere in the network, you just call us. That's single vendor simplicity.

We're the economical networking alternative to doing it yourself via leased land lines. Your costs are predictable, too. With RCA Cylix, you're on-line all the time, but you're only charged according to the amount of information you send . . . and there are no mileage charges.

Regionally or nationally, and the farther apart your terminals are, the greater your potential savings

Do it Yourself

obtain, but with some ingenuity and persistence, paths can usually be found even at these crowded frequencies.

Private cable, particularly fiber-optic cable, is now even more attractive economically for large-volume users. The problem is availability — in this case, the availability of physical right-of-way. The required right-of-way has two forms: the right-of-way from the municipalities through which the cable must pass and the right-of-way on the pole line or conduit from the utility that owns the facility. Again, as in microwave, some ingenuity and persistence can usually help obtain the right-of-way, but there may be a one- to two-year delay.

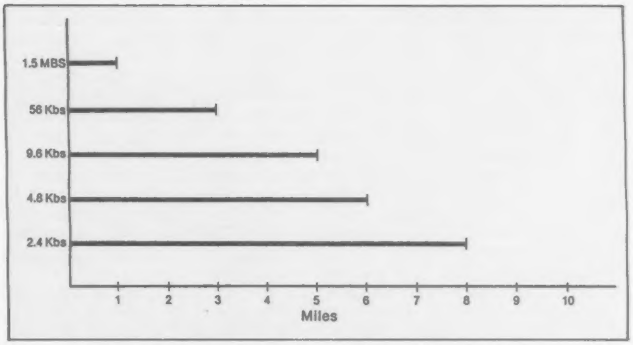

Figure 2. Transmission Capabilities of Twisted Pairs

DTS, the broadcast microwave service approved last summer by the Federal Communications Commission, is an alternative for an urgent installation in which a year or more delay is unacceptable. The limitation of DTS is the narrow bandwidth of the serving spectrum. The effective spectrum that can be offered between any two points is a maximum of about 1.5M bit/sec. The implication of this limitation is that the service only becomes cost-effective with data circuits in the 20K to 200K bit/sec aggregate range. Voice circuits would be more economically served on regular telephone company lines.

CATV is a major sleeper among the potential bypass services. Its bandwidth capability is far superior to any of the other alternatives, except, of course, private coaxial cable. However, CATV as a bypass medium has a number of limitations, most of which are related to the business strategy of the CATV operators themselves.

First, CATV does not exist everywhere. In most of the largest cities, the downtown sections have yet to be wired. Where they are wired, they are often segmented by different CATV operators, few of which are interconnected to each other. Most importantly, CATV operators are in a different business today, and the problems and opportunities of their existing entertainment business are sufficient to occupy most of their attention for years to come.

On the other hand, this situation is changing. The downtown wiring is moving. Interconnection will occur. The potential rewards of the telecommunications business will draw CATV operators, either with their own efforts or, more likely, in partnership with other firms such as MCI. Other alternatives such as cellular mobile radio, FM sideband, optical-free path links and so on will have little impact on the intracity circuit market.

It is possible to estimate the total number of circuits served by these alternative technologies at about four million lines by 1990 — about 2% of the total local circuit market. Since almost all these bypass circuits will be used by business, the business market fraction represented is about 6%. Similarly, about 8% of the local data circuit market, estimated at five million circuits in 1990 (see Figure 2), will opt for bypass technologies.

The rest of the local circuits, voice and data, will stay with the local telephone company copper-wire circuits. There are a number of reasons for this continuing dominance. First, like Mt. Everest, they are there. The key variable in the local circuit business is ubiquity. The comparably important variable in the long-distance circuit business is path size — that is, the number of circuits in a transmission path. Telephone company copper wires are everywhere.

Second, these circuits can and

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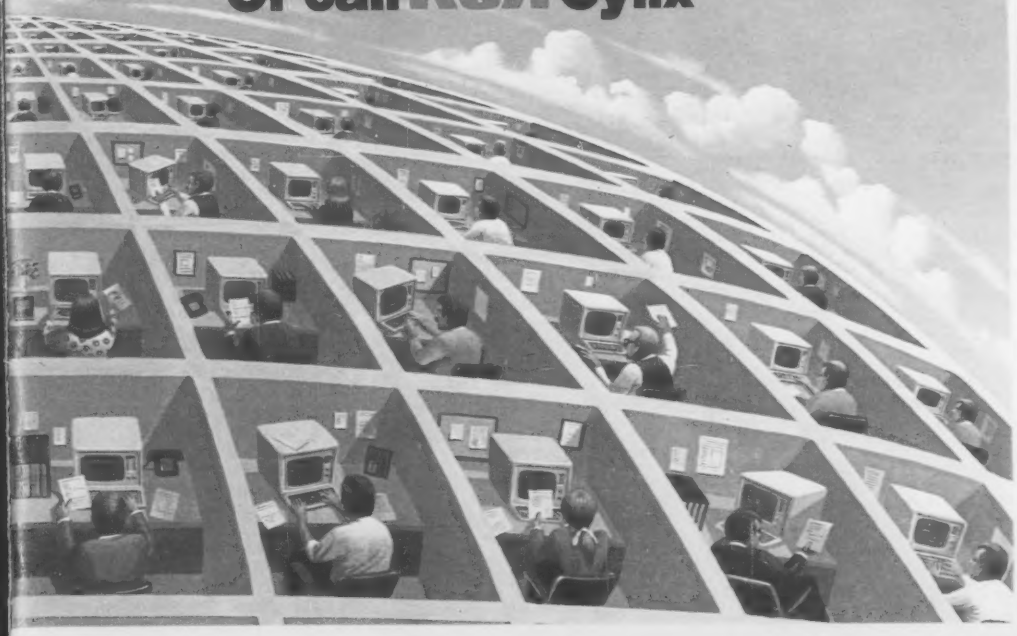


will be significantly enhanced for higher bandwidth digital services. New transmission technologies have been applied to copper wire for many years, but primarily to reduce the cost of long-distance service. This same technology is being applied now to the local copper wire distribution plant.

A copper wire is not inherently limited to a voice-grade bandwidth. In fact, modifications made to the copper wire to make it more suitable for voice transmission — for example, loading coils — make the copper wire less suitable for data transmission. Copper wire is used regularly to transmit signals in the 1M-bit range for many miles (see Figure 2 on Page 69).

The telephone companies are planning to make several enhancements to the data-carrying capabilities of the copper wire plant. These include:

- Circuit-switched digital capability. A 56K bit/sec alternate voice/data service using a technology called time compression multiplexing.
- Local-area data transport. An 8K bit/sec simultaneous voice/data capability.
- Terrestrial digital circuits. An already tariffed 1.5M bit/sec local private line capability.

Finally, while the cost of local circuits from the telephone companies is almost certain to increase over the next few years due to the separation of local and long-distance service, the long-term cost outlook is much brighter. The application of digital technology to the copper wire plant will bring the cost of local circuits down.

There is a great deal of sound and fury about new bypass technologies and their ability to save money for users, but there are some factors that need to be faced.

First, telephone company local loops are the first and last resorts if no other alternatives fit. More importantly, if other alternatives fail, there will always be the telephone company circuit.

The second factor is voice circuits. Whenever a user has a need for a data circuit, there is almost always a need for a voice circuit as well. Usually, there is a need for many more voice circuits than data circuits. In most cases, the line can be paid for by the voice circuits, and the data can ride free.

The third and most important factor is staffing. Users face a rapidly changing supplier picture in communications. The Bell system is no longer a single supplier. Users are forced to make more of their own vendor selection decisions, and the addition of the selection of local loop suppliers may be more than the users' internal staff can handle.

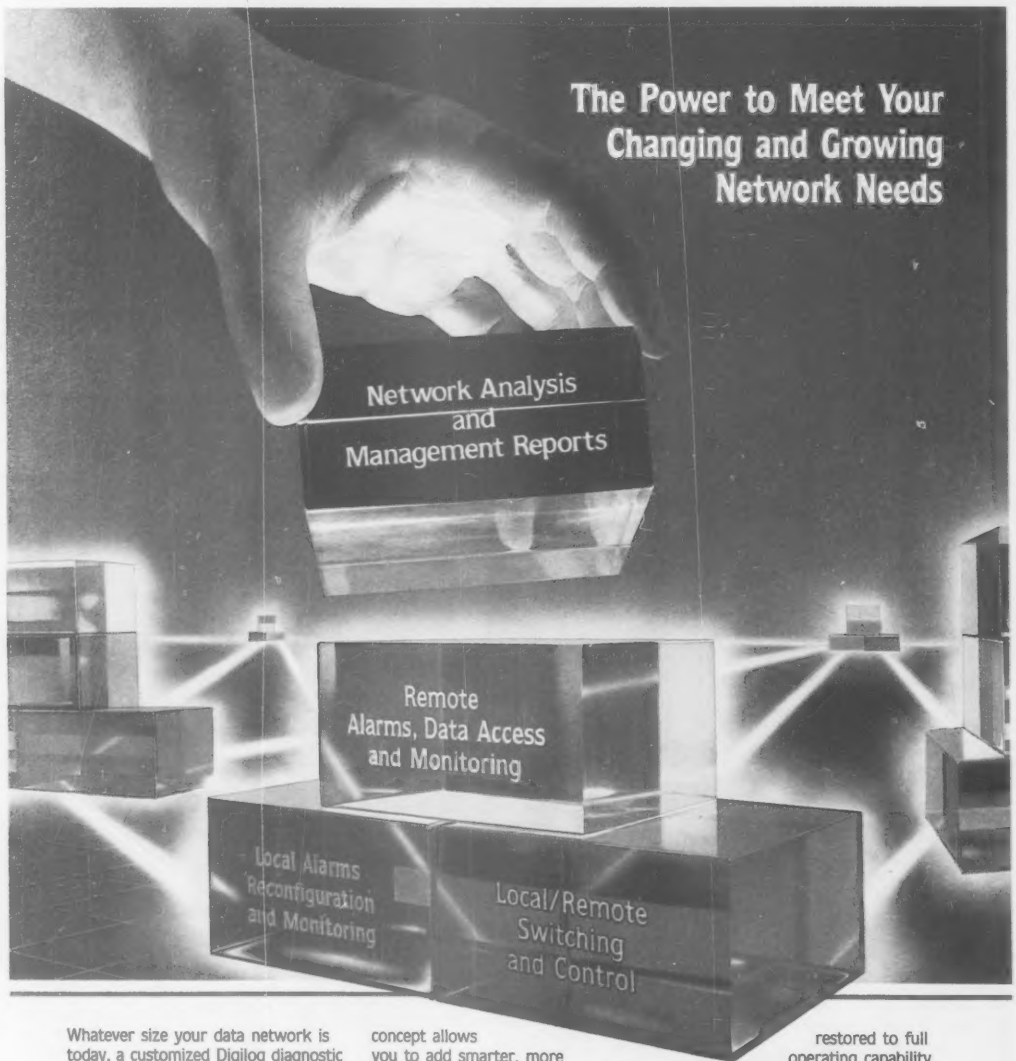
Another important factor to consider is planning. Users typically fall short in the planning of data communications requirements — and often for very good reasons. Nevertheless, if a high-cost facility such as a private microwave or private cable is being considered, requirements planning is a necessity.

Coordination with voice requirements can provide the volume cushion that allows errors in assumptions of data communications volumes. Many companies have finessed the difficult data communications requirements planning by simply installing excess capacity on an otherwise voice network.

Finally, it is necessary to consider facility sharing with other organizations. Many companies have operations in multitenant buildings or complexes. While the intracity network requirements of these entities are probably different, there is almost certainly some overlap in at least their long-distance access requirements.

Intracity data communications is about to become another competitive battleground in the communications industry. The prepared user will be able to reap significant rewards. Other users can expect to see increased costs as well as an increasingly confusing array of services. ■

O'Brien is vice-president of research at Perspective Telecommunications Group, Paramus, N.J.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A local-area network is a data communications system that flexibly connects computers, terminals and other data processing devices in a building or group of buildings within a few square kilometers. Someday, local-area network outlets may be as ubiquitous as electric power outlets or telephones. Before this can happen, the local-area network industry must develop effective, economical ways to provide privacy and security.

Why worry about security? Paper mail and telephones do not promise security, but they are used anyway. Local-area networks differ in two ways. First, in many local-area network designs, each message sent by any user can potentially be read by every user, so a single wiretap to any point can get everything. Second, most local-▶

By Robert W. Shirey

area networks carry digital messages. Digital means easily computer-readable — that is, easily searched, sorted and analyzed. By combining these two features, a wiretapper can quickly strip a local-area network of whatever privacy exists in mail and telephone messages.

Local-area network hardware is an off-the-shelf item today, but the software is still being researched, particularly for security problems.

A local-area network consists of a passive transmission medium and active interface units that connect computing devices to the medium. The medium may be tangible or intangible. Coaxial cable, twisted-pair wire, optical fibers and radio and infrared waves are all used. Tangible media are generically referred to as cable.

The interface units talk to each other according to a protocol set. They have two working parts: electronics that physically send and receive data bits via the medium and a set of microprocessors that implement additional communications protocol layers on top of the physical one. It is assumed that the communications among interface units involves packet switching, but this assumption has little effect.

A local-area network is a distributed computing system — that is, a system in which a single set of related computing tasks is dispersed across two or more physically separate and autonomous — but cooperating — physical computing devices. A local-area network is also a communications subnetwork of one or more distributed computing systems formed by devices attached to it. A local-area network uses horizontal distribution, in which the interface units interconnect and cooperate as equals.

Potentially, a distributed computing system has many functional, economic and psychological advantages over centralization. Functional advantages include greater service continuity, smoother growth, easier restructuring and simpler development. These result from the modularity in a distributed system. In particular, a local-area network reduces equipment location restrictions, increases terminal versatility, simplifies user interfaces, separates communications processing, supports resource sharing and integrates heterogeneous equipment.

Ideally, a local-area network also offers transparency, high performance and interoperability. Transparency means that a local net user — an attached device together with its human attendants — need not know how the local-area network operates internally. A local network installed in a building can be invisible, except for its sockets in the walls of each room.

Performance is related to transparency. A local-area network is not transparent unless it moves data between two devices almost as fast as data moves when the devices are directly coupled. Local-area network connections between devices can be many and varied. Today, they are mostly slow, such as between a dumb terminal and its host. Only a few specialized local-area networks support fast transfers between hosts.

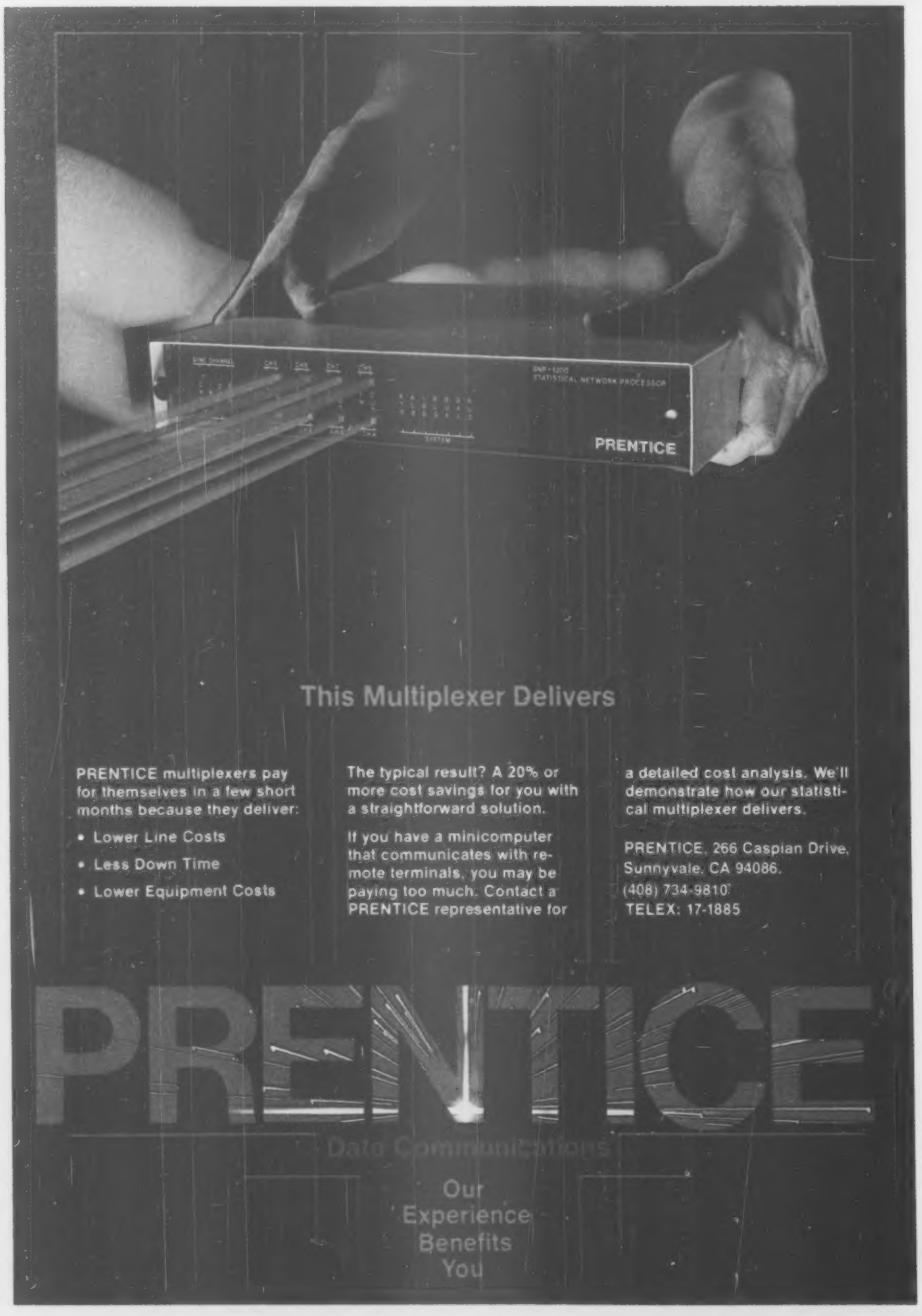
But speed distinctions between terminals and hosts are blurring. Terminals are evolving into workstations with much computing power and storage. Future local-area networks must serve a spectrum of device speeds and capabilities, including smart copiers, mail handlers, digitizing voice exchanges and teleconferencing mediators.

Interoperability is also related to transparency. Local-area network communications should be possible from terminal to host and from host to host. Equipment is readily available for the former, but not for heterogeneous computer-to-computer communications.

Local-area network users should also be able to communicate over long distances via a gateway to a long-haul network. As a result, local-area networks need a layered set of protocols to support all computing devices in the local-area network environment. The protocol set must span network boundaries to cover local and long-haul networks and internetwork gateways.

The U.S. Department of Defense's (DOD) Internet Protocol (IP) and Transmission Control Protocol (TCP) comprise the only currently available standard set that provides this coverage. The International Standards Organization's (ISO) OSI architecture and its nascent protocols do not yet adequately address internetworking. Ideally, given a full, seven-layer complement of ISO protocols, the lower four layers should be implemented in the local-area network interface unit and gateway mechanisms should be provided.

Local-area networks also need data security — protection of data from accidental, intentional or malicious modification, destruction or disclosure. A security design should preserve the modular-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ity, transparency, high performance and interoperability characteristics of the local network.

The cost of data security must be weighed against the data's sensitivity, so data is classified and assigned to one of a series of increasing sensitivity levels that merit increasing amounts of protection. Because not everyone needs to know all the data on a given level, levels are further divided into compartments. Thus, a classification or security level is a combination of a sensitivity level designation and a set of compartment designations from that level. People are cleared to access security levels of increasing sensitivity and restriction by background investigations of increasing detail and cost.

For example, suppose a collection of computing devices is running at two different security levels — confidential and secret. One is a terminal that sends and receives data at only the confidential level. It connects directly to a host on which all computing is confidential, so the terminal and host are protected only to confidential and their operators are all cleared to confidential. Similar terminal-host systems operate at secret.

There is also a data base machine containing both confidential and secret data, but running "system high" — that is, all data processing in the system is treated as having the same security level as the highest level in the system. Therefore, the data base machine can only be accessed by secret users. Any attached device must be protected and their operators cleared to the secret level, even if they only need to access confidential data.

A machine trusted to maintain separation between data of different security levels would be more useful. This would allow multilevel operation in which a system concurrently stores and processes data of different security levels, allows concurrent access to data by users having different security clearances and automatically maintains proper separation between the levels. A system is multilevel if the boundary between two security levels passes through the system.

Suppose there is a multilevel data base machine with both confidential and secret data. Some terminals are protected up to the secret level and their operators have secret clearances. Most terminals and operators, however, are at the confidential level. This reduces security costs significantly.

Next, suppose a local-area network is installed to gain distributed computing system advantages. The local-area network replaces all direct connections between terminals and hosts. A local-area network is a system that concurrently stores and processes data of different security levels and allows concurrent access to data by users having different security clearances. The local-area network is now in multilevel operation, but is it multilevel secure? Can it be trusted to maintain separation between security levels? If not, the local network must operate system high. This entails protecting all attached devices and clearing all users to secret, which would greatly increase security costs.

A local-area network that acts as though each connection between users is protected in its own private local-area network is needed. This is hard to build, partly because there are many security problems.

These problems fall into four categories. First, data may leak out of the local-area network, revealing secrets. Second, data may leak in, destroying user data integrity or disturbing local network operations. These threats are called passive and active wiretapping. Passive wiretapping involves observing the data stream, but not modifying it. The passive wiretapper can read user data and also analyze local-area network control data and traffic statistics to make inferences about users and user data. Active wiretapping means modifying the packet stream for various effects.

The third and fourth problems are access control and level control. These threats involve incorrect operation and unauthorized use of an interface unit. Access control has two forms. Partial access control means that the local-area network delivers data to a user only if the data is addressed to that user. This control requires that:

- A source interface unit that receives data for transport from its attached user knows with certainty the destination address of the data and correctly places the address in the packet.
- The local-area network keeps packets separated — not mixing data and/or an address from two different packets.
- The local-area network protects the address against change while the packet is in transit.
- Every interface unit can positively identify its attached user.
- No interface unit delivers a packet received from the local-

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area network transport medium to its attached user unless the packet is so addressed.

Level control has two forms. Destination level control means the local-area network delivers data only if the data's security level is less than or equal to the security level of the destination user. Again, the local-area network must meet five requirements:

- A source interface unit knows with certainty the security level of data received for transport and correctly places the security label in the packet.
- The local network keeps packets separated, not mixing data and/or a security label from two different packets.
- The local network protects the security label against change while the packet is in transit.
- Every interface unit knows with certainty the security level of its attached user.
- No interface unit delivers a packet received from the local-area network transport medium to its attached user unless the packet's security label is less than or equal to the security protection level of its user. If this test is strengthened to disallow the "less than," it is called strong destination level control.

Source level control means that a local network accepts a packet for transport only if the security level of the packet is greater than or equal to that of the source user. There are two local-area network security problems: separating user data of different security levels and protecting data against wiretapping. Level separation is mostly an interface unit problem, and wiretapping is mostly a medium problem. There are four approaches to separating data, and there are two approaches to protecting data from wiretapping.

Separate local-area networks combined with physical security can guarantee separation. But with this method, network interoperability between levels is impossible. Furthermore, if many security levels are in use and if many users need access to many levels, this method can multiply costs by the number of security levels. This method's technical simplicity, however, can make it less expensive and less risky than other methods if the users' security levels overlap only slightly.

Physical channels are created at the electromechanical layer. Electrically, for example, separate radio frequencies can be used with a broadcast access method on a cable bus. This method has physical limits on how many channels can be made, requires special care to prevent one channel from interfering with another and has a lower transmission speed per channel and a lower total bandwidth per system than when there is a single large channel. Mechanically, each interface unit can be attached to several different media — such as several different physical cables, one for each security level to which the attached user is cleared. This increases investment cost.

An interface unit attached to several cables or channels is a bridge — a device through which packets can travel between two separate local-area network user communities. When the communities have different security levels, the bridge must be trusted to prevent any data from flowing from a higher to a lower level.

A computing device is trusted when its hardware and software have been specially treated to ensure that it will not inadvertently or maliciously move data to a different security level. There are increasing degrees of trust, which in turn have increasing costs. When a bridge is trusted to allow data to move between security levels, particularly downward, it is called a guard.

In a local-area network, a wiretap is equivalent to an unauthorized and presumably clandestine interface unit attached to the medium. One way to prevent wiretaps is to make all attachments impossible, whether mechanical or electromagnetic. Prevention must extend over the entire local-area network body including medium, interface units and any access line from the interface unit to the user's security perimeter.

Sometimes protected wire cannot be used, particularly with an intangible medium. When possible, it is almost always expensive and inconvenient. Even in modest structures, much cable is needed for full coverage, yielding the advantage of no restrictions on user equipment location. Sealing a cable in welded conduit plugs many leaks, but it is hard to maintain and must be inspected regularly. It cannot be routed through concealed spaces without additional, expensive tamperproofing.

The alternative to protected wire is encryption — concealing the meaning of data by changing the intelligible plaintext into unintelligible ciphertext. The encryption algorithm is assumed

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known to all, but its operation can be varied radically by changing the key, a relatively short character string that is kept secret.

Encrypting packets between interface units prevents passive wiretapping, but attacks cannot always be detected. Combined with a reliable transmission protocol, encryption can detect and counter active wiretapping, although attacks cannot always be prevented. The active encryption method is well-known for communications in general and is on its way to standardization. Like protected wire, active encryption is expensive and inconvenient in anything but a trivial local-area network. However, when properly installed, it can also separate security levels.

In the next method, the interface units split a single physical channel into logical subchannels. By definition, this method sends plaintext on the medium, so physical protection for the medium and protection for the interface units and their users are required. Each interface unit is trusted to enforce level control. It should also enforce simple access control, but if it does not, the worst that can occur is a need-to-know violation within the granularity of the defined security levels.

A design has been proposed for a trusted interface unit with three variations. The first is a single-level trusted interface unit. It has a security processor inserted into the interface unit protocol structure between the link layer (ISO OSI Layer 2) and the network layer (ISO OSI Layer 3) processors.

The security processor enforces both strong source-level control and strong destination-level control on all packets going to or coming from the user device. It is assumed that the user device runs system high. All data sent by a user is automatically labeled by the security processor with a fixed security level, and no packet is delivered to the user unless it is so labeled. Thus, none of the protocol processing above the security processor layer is multilevel.

It is assumed that physical protection and check sums prevent the label from being changed in transit. The security processor would be implemented in a custom chip with the security level burned into it. The physical and link layers could also be built that way. Together, this hardware is fairly simple, so the designers believe it would be relatively easy to trust.

With single-level trusted interface units, a simple multilevel local-area network can be built. Overall, the local-area network operates multilevel, as do all the trusted interface units, because they access all the packets on the medium. However, any single connection between users is single-level. Successful development and accreditation of a simple multilevel local network would be a big step in the DP security field.

If a local-area network has trusted interface units operating at more than one level, the medium still needs system-high protection. In many cases, only a small percentage of users are at the highest security level, so much would be spent on the medium to protect little. The designer's solution is to break the local-area network into zones that differ in security level and are connected by bridges.

Suppose all secret users in a 10-floor building are moved to the tenth floor. Two physically separate local network cables are installed, one for the tenth floor and one for all other floors. All interface units on lower floors are trusted interface units at the low level. The tenth floor has some interface units at each level. The cables are joined with a bridge, which has physical and link layer protocol processors for each cable with a single low-level security processor in between.

The bridge is like two cut-down trusted interface units placed back to back. The cables and their trusted interface units are a single address space, and the bridge trusted units are modified to accept and pass across the bridge every low packet with an address on the other cable.

The break is now transparent to the users. The connections that can be made between users are the same as if a single medium with trusted interface units had been used, but the requirements for physical protection are greatly reduced. Bridges are for connecting zones that are close together. For widely separated zones, half-bridges connected by an encrypted wire that is not part of the local-area network medium have been suggested.

The bridge will probably experience performance problems. Although it can be called simply a bridge, it is really a gateway between two networks. It will experience congestion and other internet gateway problems. A gateway needs protocols above the security processor layer to handle these problems. Adding a third-level or network-level protocol to the bridge will make it much harder to trust.

Suppose the terminal interface units on the secret users are changed to enforce only weak level control. Low users can now send data to secret users, which could be very useful. However, a low user cannot know whether a message is received because low-to-secret flow is strictly one-way. Not even acknowledgments can return, so a reliable transport protocol, like a telecommunications protocol that sends back acknowledgment packets, cannot be used. The user is restricted to unacknowledged and potentially unreliable datagram service.

To allow reliable but limited interaction between zones, a guard can be built. It attaches to the secret zone cable by two interface units — one low and one secret. The guard intercepts secret acknowledgment packets bound for the low zone and changes their security label to low. Constructing such a guard is a current research problem that involves many security issues.

The second trusted interface unit variation is a variable-level trusted interface unit. It has a manual switch to allow the user to change the trusted interface unit security level. This trusted unit for terminals allows access of different hosts at different security levels. This useful feature, however, offers no guarantee that all memory in the terminal is erased before the security level is lowered.

The third variation is a multilevel terminal interface unit. Its security processor makes sure that security labels are within a certain range — from lowest to highest. It delivers packets to the user if the labels are not above the highest level and transmits packets if they are not below the lowest level. It assumes that the user is secure over the levels lowest to highest and trusts the user to tell it the security level of packets sent by the user.

The multilevel terminal interface unit is much harder to build than the single-level or variable-level unit, because protocol layers above the security processor must also be trusted.

The logic of Levels 3 and 4 generally involve 10 times more instruction than Levels 1 and 2. The cost of verifying such a terminal interface unit must be weighed against its benefits. For now, no certified multilevel user devices are available, so the benefit is nil.

Local-area network, physical channel and logical channel methods need additional protection to prevent wiretapping. When the medium carries plaintext, protection means physically preventing access. The protected wire method is sometimes impossible to use, sometimes impractical and usually expensive. The alternative is to encrypt. A user could encrypt before handing data to an interface unit, but it is assumed that an interface unit receives cleartext from the user and is responsible for all encryption.

Suppose a local-area network has two interface units with secret users and two with low users. The interface units with secret users share an encryption key that only they know. They use the key to encrypt all user data. This not only protects the secret data against disclosure to wiretappers, but also protects it from users on other interface units. The interface units with low users have a second secret key to encrypt their traffic.

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The combined encryption separates the two security levels on the local network.

As with single-level trusted interface units, the local network offers simple multilevel security. The trusted interface unit hardware and software are trusted not to disclose classified data by putting it into the medium as plaintext, but unlike the trusted interface unit case, all local-area network components are completely single-level. Each trusted interface unit has access to plaintext user data of one security level, and the medium holds none. This makes such a local-area network less expensive to certify.

The local-area network encrypts the user data, but what about the local network control data, particularly the source and destination addresses in each packet? Unless control data is encrypted, a wiretapper can analyze it, which might provide information that is as or more valuable than the plaintext user data. Encrypting addresses increases trusted interface unit computing in two ways. First, each trusted interface unit decrypts at least the destination address of every packet on the medium in real time. Decrypting with the wrong key either produces the wrong address or an accidentally correct address detected by a header check sum.

Second, a trusted interface unit might hold more than one key under which it might receive a message. If so, it decrypts each packet addressed to it once, on the average, for each two keys it holds. Worse, it decrypts each packet not addressed to it with every key it holds. To avoid this, trusted interface units can encrypt in two steps. Control data is encrypted with a key held by all interface units at the same security level, and user data is encrypted with a different key unique to the connection. Each trusted interface unit then decrypts every passing packet only once to try to see the address, and control data is confined to its security level.

This scheme can also help a trusted interface unit communicate with two other trusted interface units that are at the same sensitivity level, but in different compartments. First, the trusted interface unit encrypts the user data with a key assigned to all trusted interface units with the same compartment subset. Then it encrypts the local-area network control data with a different key assigned to trusted interface units with the same sensitivity level.

With headers encrypted, a wiretapper still can analyze the frequency and size of packets. The usual approach to this problem for a point-to-point communications line is to send a continuous stream by filling gaps in user data with dummy data and encrypt the entire stream. This contradicts a major aim of packet-switching schemes; channels are allocated as needed to improve channel utilization compared with circuit switching or message switching.

Encryption has costs for key generation, distribution, installation and maintenance. In the worst case, in a network with N trusted interface units, each trusted interface unit must store a file of N-1 keys, one for each of the other units. To avoid this storage and the attendant problem of updating the distributed and replicated key data base, a network can use a key distribution center that distributes keys only as needed. Each trusted interface unit then stores one master key that protects that unit's communications with the key distribution center.

Key distribution is a form of overhead. If an interface unit requests a new key for each session, overhead becomes substantial as sessions become shorter, tending toward the extreme of only a single transaction message per session. At least three different methods exist to reduce calls on the key distribution center.

First, interface units can store and reuse working keys subject to limits that prevent cryptanalysis. Second, in a public key cryptosystem, the public keys can be listed and widely distributed in a directory. Third, a working key can be generated for each transaction by the source interface unit and sent along with the transaction message but protected with a separate master key. The working key may even be derived from the message. For example, the message may be selectively encrypted, with the unencrypted portion determining the key for encrypting the rest.

Early proponents of public key cryptosystems felt these systems would not need the secure initial distribution of master keys needed in a conventional cryptosystem. That is not so. In a public key cryptosystem, there must be a way to authenticate public keys when they are posted in the public directory. Otherwise, one party can pose as another.

So key distributed systems in both conventional cryptosystems and public key cryptosystems need an initial out-of-channel exchange to establish a master key. Of course, any key distribution center must be trusted at least to the same degree that encryption is being relied on to provide security separation. Constructing such a key distribution center is a current research problem that involves many security issues.

Someone who buys and installs a secure local-area network today has few choices. Either the local network runs system high or uses a combination of physical separation of security levels and protected wire. This implies that the medium must be tangible. In the next year, commercial interface units with data encryption standard (DES) encryption, end-to-end encryption and key distribution algorithms probably will be sold. But the buyer of a DES local-area network should be wary about the degree of formal trust that can be placed in it. That is, a local-area network using DES for end-to-end encryption looks easy to build, but the process of defining, quantifying and assuring its security properties is extremely difficult.

Looking ahead three to five years, trusted interface units, with or without encryption, will be commercially feasible from a technical viewpoint. How many are offered for sale will depend on demand; so far, the commercial market for computing security gear has been sluggish.

If someone buys now, but plans to buy better security technology later, there is little that can be done to prevent scrapping the first system when installing the second. Today's media, of course, are likely to have a long life. As new uses rapidly consume bandwidth, media will likely be augmented or duplicated, not ripped out and replaced. But it is not likely that many of today's interface units will be able to be upgraded or retrofitted for advanced security technology. This does not mean that interface units will be thrown out. No one ever has enough of them, and the older ones will support applications that do not need strong security. ■

Shirey is a group leader at The Mitre Corp. in McLean, Va.

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CONVERGING COMMUNICATIONS SERVICES

By L. Daniel O'Neill

Over the past 15 years, the telecommunications industry in the U.S. has undergone substantial change. As a result, the industry, once stable and staid, is now the driving force of a new economic and social era. Yet it cannot be said that this change has been part of any distinct national policy or long-contemplated national plan: It has arisen accidentally, generally driven by the same evolutionary technological forces that it is itself now driving.

This evolutionary, unplanned, even uncontrolled structural change was made possible by three distinct characteristics of the industry itself. First, unlike its equivalent in almost every other nation in the world, the U.S. telecommunications industry grew up as a private industry. Government policy control over telecommunications has always been and ▶

continues to be negative rather than positive.

Second, no carrier among many in the evolving telecommunications industry was given a legal monopoly. Thus, any monopoly that ever existed in the industry was de facto, created at the sufferance of the federal government and based on political and technical circumstance. Third, telecommunications services and technology were, until the recent era, homogeneous, based on large-scale technologies and favoring large enterprises providing integrated services.

At any given time, the industry structure in the U.S. is a product of the balance among technological forces, market demand and public policy. When technology is passive and demand is stable, public policy encourages stability. When technological change is rapid and/or demand for new services is growing, public policy is forced to provide for accommodation, subjecting the industry structure to substantial change. These forces for dynamic change have governed and will continue to govern the telecommunications industry, and any analysis and forecast must take them into account.

The industry structure in the U.S. is a product of technological forces, market demand and public policy.

In the earliest days of the industry, a conflict arose between those who would vest a single entity with statutory monopoly power subject to government regulation and those who would allow free competition to reign supreme. The fact that neither was chosen in the end made it inevitable that the industry structure would be subject to pressure to change. The fact that competition was suspended between 1912 and 1968 is less a testimonial to a government policy in favor of monopoly than it is to the lack of emergent technologies that would impact the old order.

By 1968, however, all of this had changed. Competitors found a means of attacking the old order. This attack was made possible by the very stability of the then-existing structure. Thus, in a litany of regulatory decisions and court cases now well-known by even the most casual observer, the long-standing telephone company monopoly on equipment was struck down. Private microwave networks were allowed; emerging satellite telecommunications systems were specifically entrusted into competitive hands; classes of carriers in the form of resellers and the value-added service providers were allowed to emerge; and, finally, control of the entire process was wrested away from the Federal Communications Commission (FCC), and competitive, public-switched, long-distance service providers were allowed to enter the message telephone market.

These changes, however, were incremental and in many ways accidental. None of them was part of any planned exercise in national policy aimed at establishing a new, presumably more efficient, beneficial industry structure. As a result, the current industry structure is out of alignment. Changing technologies and resultant changes in customer demand and public policy have impacted different segments of the old structure unevenly. The once-unified, universal telephone industry has thus been fragmented into several market segments — two very competitive, one a little competitive and one not competitive at all.

In general, these market segments are the customer premises market, the customer premises network market, the local services market and the long-distance national services market. Most firms are active in only one of these market segments, some in a couple and a few in all four — for example, GTE Corp. Because of the uneven development of change and limitations of the regulatory process, these market segments have come to be viewed by many, in and out of the industry, as separate marketplaces for equipment and services. Indeed, public policy process itself, implemented in

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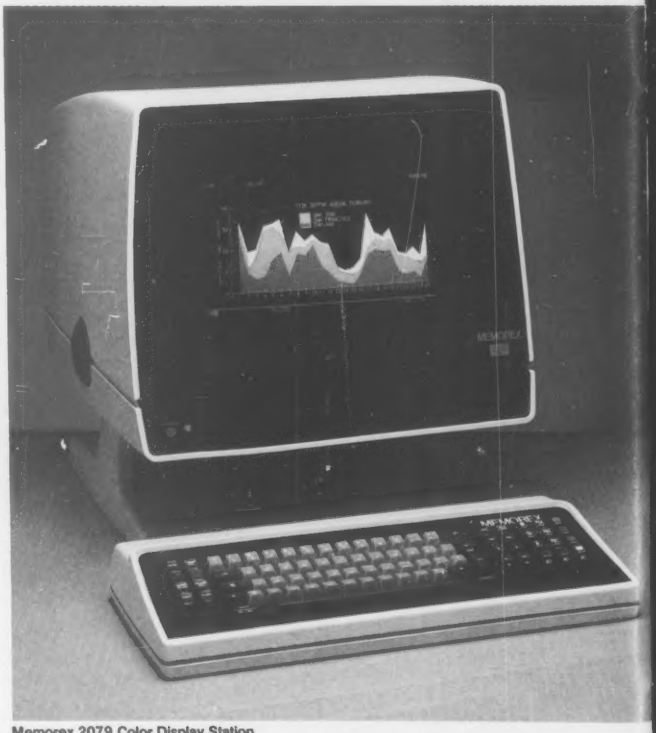

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an incremental manner, has tended to force such a separation.

Furthermore, in recognition of the incremental nature of key public policy decisions, there have been several attempts at broader based public policy reconciliation. The aim of such proceedings, although rarely publicly stated, is to rationalize previous incremental decisions via a more comprehensive statement of public policy.

The two most important such global decisions to date are the FCC's Computer Inquiries I and II and the Justice Department's settlement of the AT&T antitrust case.

In Computer Inquiries I and II, the FCC sought to make overall comprehensive policy sense out of changes wrought upon the industry by changing technologies, changed demand for services and the piecemeal regulatory response to those forces. Obviously, had it been possible for the FCC to refuse to make any change in the telecommunications industry structure, there would be no need for either computer inquiry.

> ***It is a mistake to view the current fragmented structure of the telecommunications industry as permanent.***

Moreover, the structural components of both final decisions, particularly that of the Second Computer Inquiry, are found in contemporaneous FCC decisions on matters such as resale and interconnection of terminal equipment. As a result of Computer II, the FCC — perhaps in excess of its limited authority — chose an industry structure that would allow the entry of new services and new carriers, while hoping to sustain the existing infrastructural network without significant change or adverse public impact.

In the second of these actions, the Justice Department and the federal court attempted to do approximately the same thing. While other federal courts have been active throughout the century in the telecommunications industry, particularly in overturning and upholding FCC regulatory decisions, the court in the AT&T case was poised to play a much more significant role.

The modified consent decree in the AT&T case orders the creation of a new telephone industry structure. This structure divides the industry between long-distance service providers, local service providers (although some "local" areas include entire states) and telecommunications equipment providers, generally in keeping with the structure created by the FCC and technology itself.

While this structure is not as neat and tidy at present as the court and the Justice Department would like it (primarily because the court did not have jurisdiction over that small percentage of the telephone industry not controlled by AT&T), there is no mistaking that the proposed fragmented structure is the competitive structure preferred by the Antitrust Division of the Department of Justice.

While it is natural to view the present as future, it is a mistake to view the current fragmented structure of the telecommunications industry as permanent. Currently, the U.S. telecommunications industry is in the eye of the storm. While significant change has taken place — much of which would have seemed impossible to even radical procompetitive forces in 1968 — what has happened to date is nothing compared with what will happen in the next 15 years.

A good part of this change will be incremental and, like all incremental change, inconsistent and painstakingly slow. Before the forms and the structural procedures for this change can be discussed, however, present pressures building for that change must be examined (see Figure 1 on Page 81).

These pressures are threefold — technological, market demand-based and economic. Political factors, while present, are not a catalyst for change: In this structure, political forces inhibit rather than foster, restrict rather than free and delay rather than facilitate. Thus, while political forces will surely

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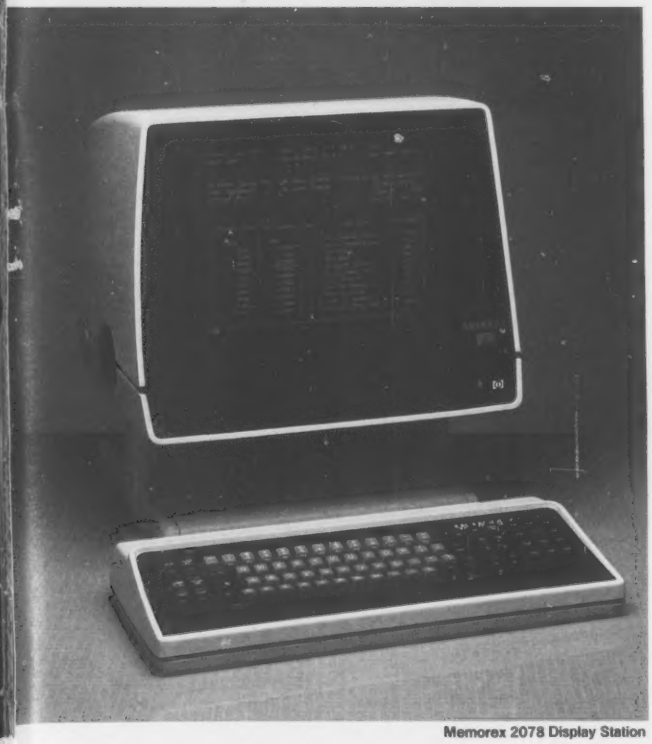

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enter this equation, their ultimate entry can only be viewed as a disruptive force.

On the technological side, significant strides are being made to foster the digitalization of telephone networks. Principally, these involve evolutionary changes in transmission media, particularly advances in fiber-optic technology and the introduction of digital switching into analog networks. These promise to make existing telecommunications systems substantially more flexible, especially with regard to data services.

> ***More and more users require data communications services for access to multiple data bases.***

At the same time that advances in transmission and switching technology are making economical the introduction of digital or digital-capable facilities, rapid changes are about to occur in the user facilities market. The rapid introduction of low-cost information processing systems is particularly important, especially in business and manufacturing environments. The introduction of local-area networks in lieu of or in addition to customer premises wire is also important.

Finally, more and more users require sophisticated data communications services for access to multiple data bases and various data collection/compilation services. It is often less expensive and technologically advantageous to integrate such services into shared facilities within network service structures.

To date, each of these factors has evolved in a semivacuum. The local-area network market, for example, has tended to evolve without significant advances in telephone transmission technology. The transmission network in the past has done more to impede than to assist introduction of data communications services.

Fragmentation and separation of services cannot survive much longer. The forces of technology coupled with demand will force increasing integration of transmission and information processing services. In anticipation of such integration, the telecommunications industry has coined the term integrated services digital network (ISDN).

The emergence of ISDNs presents a new concept in telecommunications services. Indeed, it can reasonably be concluded that such networks are not telecommunications networks, but rather embody a wholly new service — the marriage of transport services with a wide variety of what AT&T calls user applications.

Under such a scheme, visible distinctions between voice and data services, as well as between services external to the network and those provided within it, would be lost. Network access would be transparent to users with information collection, storage and processing functions situated where efficiency or user needs dictate. Multiple networks

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Within any given nation, multiple network service providers may provide services to all or most segments of the market either together, in competition or both. They will provide intelligent networks that facilitate efficient information exchange between users and/or provide information services themselves — particularly in the form of data storage and data base services.

The technological barriers to such networks are complex but easily overcome with time. A key technological problem is the development of network interfaces and interoperability standards between either national networks or among national networks in an international environment.

Interfaces fall into two categories. The first category is external interfaces — that is, interfaces between the network and other networks or between the network and users. The second category encompasses intranetwork interfaces that harmonize various components of integrated universal networks. In countries where a single telecommunications service provider furnishes all aspects of the end-to-end network, from customer premises wire to long-haul transmission, the second category is strictly a carrier concern.

In other countries, where for political reasons, a more fragmented ownership and control is desired (such as in the U.S.), the various components of an end-to-end network must be melded to retain the independence of separate service providers while at the same time augmenting network integration.

Conversely, integrating user facilities — ranging from local-area networks and sophisticated private branch exchanges to single terminals — into the network is a problem confronting all network planners. However, the complexity of this problem will vary depending on the class of users connected to the network and the kind of use made of the network services. The degree to which users will be allowed to control the nature of network functions and services will inevitably determine the degree to which users will be allowed to sell information services obtained from the integrated network to other so-called subusers.

Such integrated, interoperable digital networks embodying information service technologies may be available soon. However, the technical aspects of such systems must be subject to the political and legal framework within which they are created. This framework will determine the speed with which enhanced telecommunications/information services are introduced in the U.S. and other nations.

It is certain that the development of this political, legal framework over the next two decades will be subject to forces similar to those that have shaped the industry to date. Hence, in the development of these future networks, one must look to the interests of technological advance with political, legal and regulatory forces interacting with each other at multiple levels.

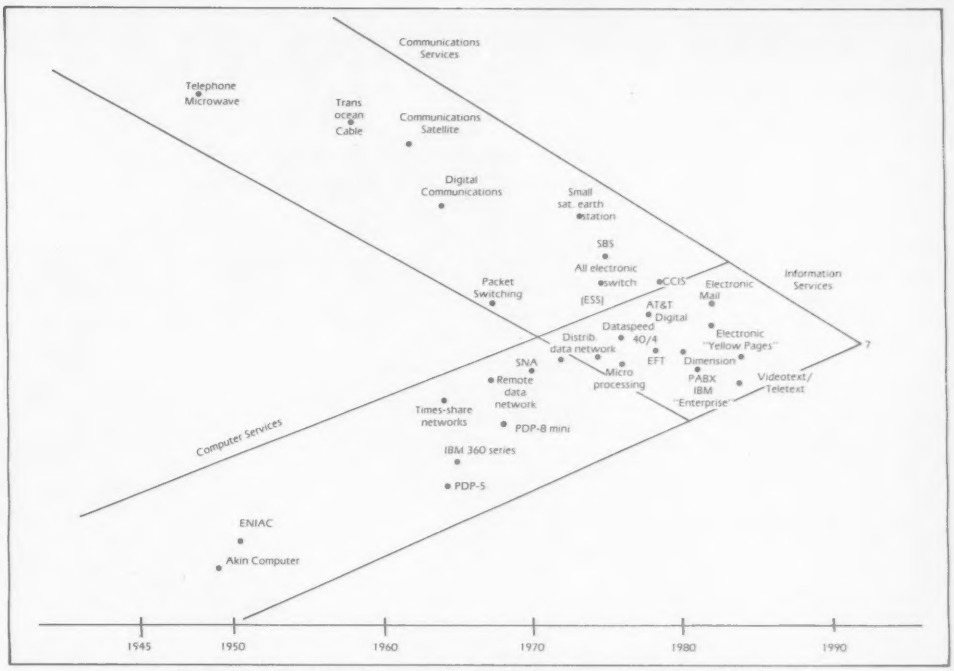

Figure 1. Integration of Computer and Telecommunications Technology

The first level will be, as in the past, focused on the day-to-day regulatory activities of the FCC and the courts. Within this framework, two distinct interests are represented, those of integrators and those of disintegrators.

Forces for disintegration seek to assure fragmentation of the overall network in order to provide maximum subinterfaces between and among multiple networks. In a disintegrated scheme, transparent interfaces would be required between local and long-distance networks, between local networks and customer premises networks and between customer premises networks and customer premises equipment. Through this fragmented structure and through restrictions on network services, disintegrators seek to maximize service opportunities for network users who are also information service providers.

The integrators are on the other side. The obvious goal of integrators is to maximize network efficiency by minimizing the number of transparent interfaces and by maximizing the integration of advanced information services into the digital network rather than into the nodes of that network.

Internationally, the monopoly postal and telecommunications authorities represent maximum integrators. Domestically, integrators vs. disintegrators are more difficult to categorize. Eventually, most large information and communications service providers must seek integration to maximize their economies of scale advantage. Nontraditional information and telecommunications firms must seek disintegration.

The actual decisions at this first level, however, will not be so broadly focused. Decisions must continue to be incremental — service by service, standard by standard, interface by interface. It is only later that a broader policy of integration or disintegration will become clear.

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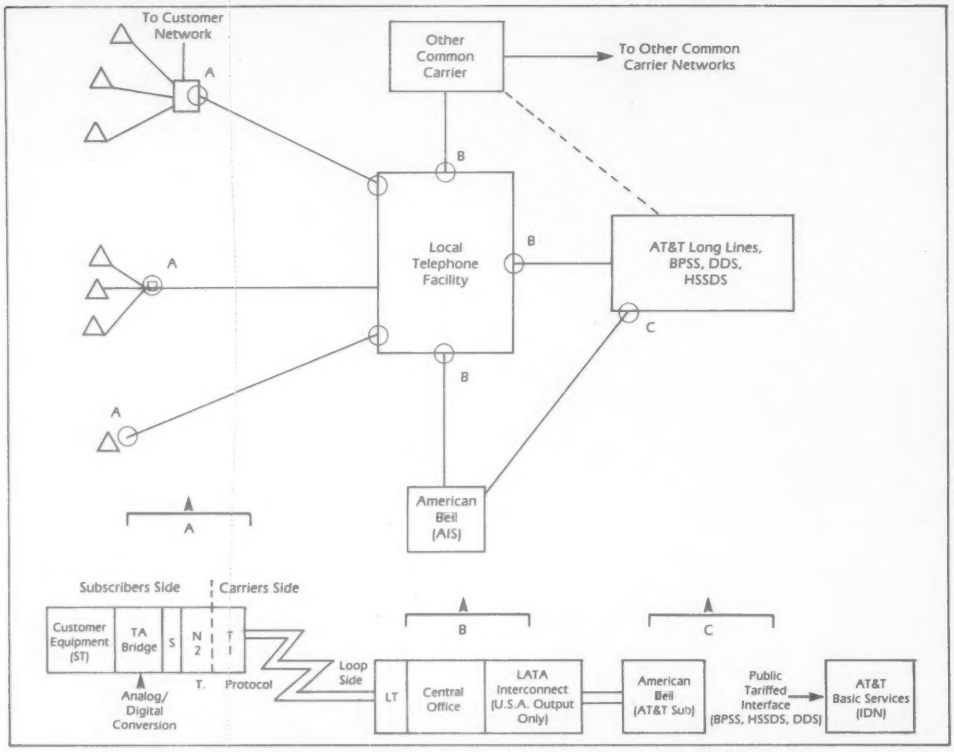

Figure 2. Key Components and Interface Points, Integrated Digital Network

will be made at a second higher level of policy making. At this level, the regulators and/or the courts pause to make sense out of past incremental decisions. Within this context, Computer Inquiries III, IV or more can be expected to emerge over the decade.

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At the same time, the U.S. District Court for the District of Columbia will implement the settlement of the AT&T antitrust suit. This process will keep the industry structure in doubt — if not turmoil — for years to come. Finally, Congress will occasionally come forward when particularly upset with the actions of any of the other major parties.

Out of this process, the telecommunications structure of the '90s will emerge. The process itself will be evolutionary — not revolutionary — and it is unlikely that individual users will notice significant changes in the availability of services from year to year. The two regulating mechanisms of this policy process are market forces — that is, the demand generated for the kinds of services contemplated in such new advanced networks and technological advances that provide cost incentives for the introduction of new transmission-switching and terminal technologies. These elements will play against each other, enforcing the incremental decisions that provide the basis for change and other policy decisions that provide the foundation for new industry structures.

It should be noted that deregulation has not been mentioned as a driving force for change in the telecommunications industry. There are two reasons for this. First, there has been very little actual deregulation in the industry: There has merely been an alteration in regulations or a conforming of regulations to meet new technological situations.

It could be argued that there is more regulation today than there was prior to 1968. The final decision in Computer II has created the framework for significant regulation in many aspects of the telecommunications industry for the foreseeable future. This is particularly true in distinctions between enhanced vs. basic services and the development of interconnection interfaces between enhanced service providers and the basic network.

Secondly and perhaps more importantly, deregulation of this industry is not seen as a meaningful option in the foreseeable future. Even under the most optimistic scenario from the deregulatory point of view — where the disintegrators are successful in creating technical separations between various network functions so that multiple competitors arise within each network function — a residual referee must ensure continued disintegration. Obviously, if the integrators gain the upper hand, serious questions will be raised about the survivability of more than a handful of service providers — certainly not more than two or three. Such a small level of competition in an industry so vital to future U.S. economic growth will require continued market administration by a national authority.

Thus, while continued emphasis on deregulation of some market segments is foreseeable, a future in overall deregulation characterized by the elimination of the regulatory mechanism is not foreseeable.

Currently, on a macroscale, the U.S. seems to be determined to maintain maximum competition in the provision of long-haul telecommunications services and full competition in the information processing, storage and retrieval and equipment markets. This emphasis on maximum competition requires a disintegrated approach in the introduction of new telecommunications services. This scenario has its foundation in the Computer II decision, its subsequent supporting decisions by the FCC, the Modified Final Judgment in the AT&T antitrust case and continuing decisions of the federal court in the implementation of the judgment.

Under this scenario, the telecommunications/information services industry is divided into five generally distinct marketplaces. These are terminal equipment, customer premises networks, enhanced services (data processing information services), local (intra-Local Access and Transport Areas) communications services and national communications services. To maintain these separate markets, regulatory forces must create deep gulfs in the form of economic, legal and organizational barriers between these markets and, in particular, between those markets deemed to be embryonically competitive and those that continue to be noncompetitive or monopolistic.

Such separation presumes minimal integration of so-called enhanced services into the basic telecommunications network and,

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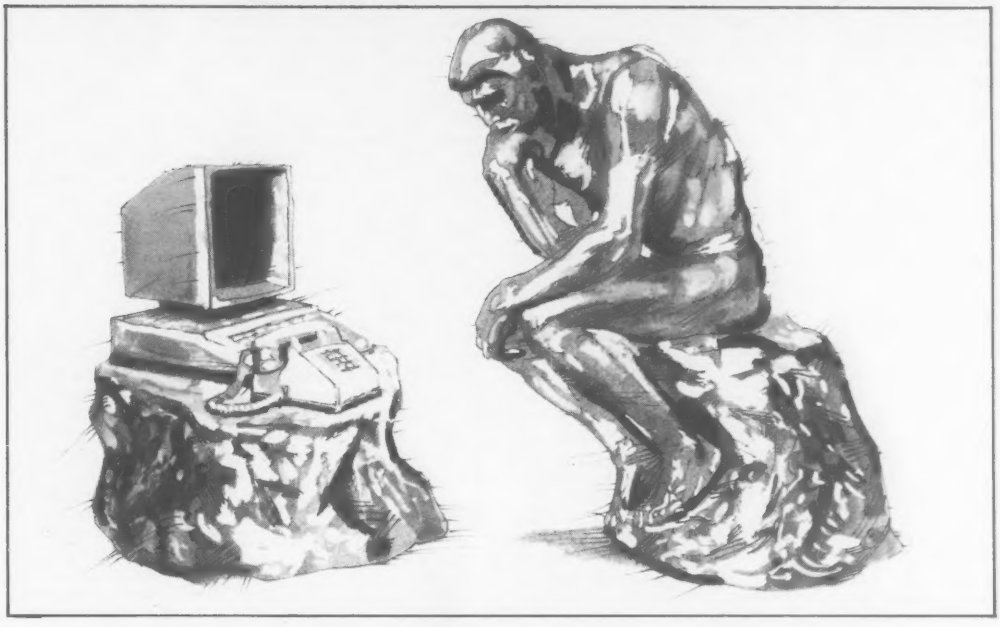

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as such, is the antithesis of the ISDN concept. Such an environment of interconnections and interfaces must be devised that allows parties external to the network (so-called enhanced service providers) to use it to provide enhanced communications and information processing services via facilities of the core network. Similar interfaces will allow private systems, usually customer premises networks, to communicate transparently with other customer premises networks via core facilities. Under such a scenario, the ongoing implemental debate will have evolved around the structure of those interfaces and the components of the core network. The ultimate goal is an ISDN.

There are several ultimate side effects to such a policy course. The first, obviously, is the explicit choice of competition over efficiency. In this case, maximum competition would seemingly require maximum inefficiency. Moreover, there is some question whether such a system, artificially constructed on the basis of maximum technological inefficiency, can survive without strong regulatory involvement. Thus, a disintegrated system may also be singularly more regulated than the current structure.

The third side effect, presuming maximum reliability and accessibility of the core network, seems to be the demise of competitive transmission networks. Competitive carriers must now evolve into enhanced service providers, making use of the universality and efficiency of the core network. Such an environment that would emerge over the next 10 years is illustrated in Figure 2 on Page 82.

The second scenario would have slow incremental changes in the basic policy position, culminating in the latter part of this decade with substantial changes in the underlying premise behind a competitive industry structure. Thus, some degree of a reintegration of communications and information services would emerge in perhaps truncated ISDNs (note the plural). However, this scenario, which is more likely, involves the most legal and political confusion. It requires the evolutionary introduction of an anticompetitive telecommunications services system in the face of a policy environment that currently holds competition as the highest ideal.

Under this scenario, the lines between the separate service segments are slowly blurred, and increasing amounts of information services capabilities are integrated into what had been a core communications network. The guise for such integration will be technological efficiency coupled with market demand. In time, the disintegrated components now contemplated under the AT&T settlement and the computer inquiry will become increasingly reintegrated.

At first, the reintegration will be subtle and the debate over it obscure, for throughout the technological reintegration process, there need not be economic or organizational reintegration. On the contrary, a network architecture will emerge that is preferential to large information service providers and which discriminates against small-scale users, resellers and other miscellaneous competitors. The trade-off involved in such a network is competition vs. efficiency, with the presumption that the most efficient solution that provides for some competition is ideal. In such an environment, a handful of large, fully integrated service network providers will develop. The exact number, of course, is unpredictable. However, it seems inconceivable that there could be more than three universal integrated services networks.

The ultimate irony is that it is more likely that new services generated by integration, enhanced information processing and digital communications will be more rapidly available in the semicompetitive, administered market environment than in the long-touted competitive framework. Moreover, it should be immediately pointed out that under either scenario, the U.S. will differ substantially from the majority of other developed nations that seem bound to develop single national ISDNs, providing transparent information processing and delivery services via massive data communications networks. Thus, under any scenario, terms of interconnection between the U.S. and its international partners will inevitably create some degree of difficulty.

Regardless of which environment emerges, the near future will be fraught with legal, technical and regulatory confusion, a conflict between future possibilities and present realities. This confusion will result in a delay in the introduction of advanced services and an inconvenience to users. Various factions will fight out their differences in technical forums. Among these, areas of specific importance are the interconnection standards established between the basic network and enhanced services providers and the categorizations used between enhanced and basic services — for example, the degree to which information services are embedded in the basic network.

Similarly, an area of key importance will be interconnect standards, if any, between customer premises networks and local telephone services on one side and terminal equipment on the other. Of crucial importance is the degree to which new communications service vendors such as IBM are allowed to embed advanced information processing services within their overall telecommunications service networks.

While we stand on the threshold of the era of truly universal, integrated, high-speed digital networks, such primitive services as mere 56K bit/sec switched data circuits remain more a promise than a reality. For many years, high-speed data services will continue to be the domain of rich, high-volume users who wish to connect fixed points via networks of actual or virtual private leased lines.

However, in addition to causing frustration, this era of transition in policy formulation will create substantial opportunities for those nimble enough to ride the crest of the wave. The same demand that will inspire the industry giants to prepare to offer incrementally sophisticated services will provide an opportunity for innovative resellers to make creative use of underlying basic communications facilities. As a result, this era will create a sequence of new information service markets that will last a few years during the course of the regulatory delay and then disappear with the entry of traditional service providers.

The telecommunications environment in the postcompetitive era can be viewed with a mixture of optimism, realism and despair. On the despairing side, even though the technology itself offers the possibility of innovative integrated voice, data communications and information processing services, these innovations are not available and show no sign of being available for actual use in the near future because of regulatory and political barriers.

On the optimistic side, the U.S. — perhaps more than any other developed country — has made great strides in understanding the scope of this technology and in developing the market for its application.

Thus, as such networks evolve, the U.S. is better prepared to deal with disruption in traditional industry structures. Moreover, the general reliance on market forces to influence the introduction of new technology assures that the eventual emerging structure will more appropriately suit communications users' needs than structures developed in more authoritative and less responsive regulatory environments.

However, on the realistic side, one must recognize that the existing environment of confusion will not reach an immediate resolution. ■

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SAN JOSE, Calif. — When Crown Zellerbach Corp.'s packaging arm, Flexible Packaging and Advanced Film, began a major evaluation effort defining long-range business direction, it was clear that the central challenge facing operations was not just the implementation of a data processing system, but one based on communications networking.

The DP system would replace a manual order entry and Burroughs Corp. bookkeeping machine billing system, integrating the two core business functions involved in getting products out the door. At the same time, the communications network would take information from data processing and put it into the hands of departments whose production decisions depended on it.

Given the organizational structure and sales strategy of Crown Zellerbach, nothing less than a computer network with multiple communications paths would make that possible. And when the firm went to match off-the-shelf technology with user and organizationally structured needs, it became apparent that there was not a readily available solution to Crown Zellerbach's business-driven requirements.

Both the Flexible Packaging and Advanced Film divisions deal in specialized product packaging that is manufactured to customer specifications and sometimes involves highly complex precision layer designs. Production for both divisions is divided among manufacturing sites at seven locations nationwide, each of which maintains an order and billing information system for its prod- ▶

uct assignments. Within the framework of Crown Zellerbach's business philosophy, both divisions have been granted decision-making autonomy with freedom to formulate independent sales strategies. The Flexible Group sales representatives sell within the immediate manufacturing site area, and they conduct business with a local-presence sales approach. Accordingly, the sales function resides at the manufacturing site.

The Film Group, on the other hand, takes a national field service approach, permitting its sales force to cross-represent products from any manufacturing location. This strategy requires seven sales offices that are remote from manufacturing sites.

But the net result is that both divisions sell different products to the same customer — as many as four and five in a given time frame. Sales representatives from 14 offices go through seven different manufacturing sites to place orders and originate information processing. And both sales forces are responsible for a customer's total current portfolio through the finished status, regardless of how many products and manufacturing sites are concurrently involved.

So when a customer inquires about product status, sales and customer representatives on one end have to seek out several sets of information from multiple personnel and department levels at the other end, across manufacturing plants. Furthermore, the progress of production phases depends on the product's related information movement from one department's processing on to others. At any point along the critical order entry path, a communications bottleneck of any sort impacts the whole continuum.

For these reasons, Crown Zellerbach required a multipath communications ability — a system mechanism that would tie together product information across numerous locations, compressing the product information cycle into one critical multiaccess point for the entire organization and upholding one Crown Zellerbach interface for customers' product concerns.

Crown Zellerbach moved to confront the key business problem facing it: information and data management. It would set up a computer network structure geared specifically to fill remote locations' needs to communicate with one another.

Following an in-depth review of available hardware alternatives, an equipment base was installed consisting of IBM System/34s at all manufacturing sites and remote IBM 5251 terminals and printers at all 14 sales locations. System/34s supply processing power on a distributed basis to manufacturing sites, and sales and customer service representatives can dial up the data bases from their remote IBM 5251 workstations.

Among the vendor possibilities considered, IBM hardware stood out for its business orientation, complemented by a myriad of available business applications. Equally important, IBM's Systems Network Architecture (SNA) offered a total spectrum of IBM networking communications: greater flexibility in interconnecting processors, access to any applications program from any terminal in the network and sharing of resources among host processors in the same network. This provided Crown Zellerbach the elements for a data communications system software solution: business applications and remote communications brought together by the network.

But perhaps the most important part of the decision was assessing the user-friendliness of hardware alternatives. If intimidated by high-technology content, end users might back off from the system or only marginally use applications developed by Crown Zellerbach at substantial cost. Since the overall success of the network would be a direct result of its usability, Crown Zellerbach sought the distributed solution offering the simplest entry-level architecture while still giving applications capacity on a par with the mainframe.

Avoiding a mainframe as the centerpiece of the network was one concern that led to the IBM architecture. In the first place, Crown Zellerbach did not want operations held captive to tight network control, demanding specialized data processing expertise. Second, a mainframe would deepen the capital-intensiveness of the project.

Of course, the Crown Zellerbach management task force recognized it did not need to move information back and forth from each plant location to a central mainframe merely for the sake of consolidation. Instead, each manufacturing plant needed to process information at the place where the work was done, then

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share the information company-wide via computer communications.

Drew Wall, controller of Crown Zellerbach's Group Management Systems, said, "None of the hardware vendors have a solution for the decentralized data processing environment with master files maintained in a distributed fashion, but with access universally.

"You see it in the press, talk about it, but it doesn't really exist," he said. "Minicomputers don't talk well with one another. All the manufacturers have assumed that somewhere along the line there will be a big box in the middle of them. What do you do if you don't need a mainframe?" he asked.

Once it was determined that IBM System/34s would serve in place of a mainframe, selection of IBM 5251s followed as part of an all-native IBM architecture to provide compatibility across the network.

While hardware selection came easily, given Crown Zellerbach's clear-cut objectives, communications capabilities proved a dilemma. Out of accepted practice, it seemed plausible to use dial-up access, the method linking many corporate networks. The dial-up approach seemed almost inevitable, since no other solution allowed connection of remote IBM 5250 terminals with multiple hosts.

But there were problems foreseen with the dial-up approach, which stemmed from the System/34's port limitations. A System/34 has only four communications ports with which to support communications with a network's remote devices. One dial-in terminal talking with a System/34 takes up one port, and four remote terminals use all four — at which point, System/34 access is totally exhausted.

The resulting problems are illustrated by the network in operation. First, availability of the system is limited to users on a first-come, first-served basis. When four remote locations make System/34 connections — that is, each occupy a port — it is easier to hold on to the connection throughout the day than to give it up and attempt recovery in competition with other users later on. During this day-long attachment, other bidding locations draw a busy signal, shut out from access to the System/34 and its data base. The port limitation, moreover, increases when a user from Phoenix, for example, dials into Los Angeles, thus forcing all terminal peers at Phoenix to talk to Los Angeles. For a big-ticket computer system upon which an entire information-intensive organization depends, the inability of the System/34 host — where investment dollars are concentrated — to extend usage beyond a mere four users is simply not cost-effective.

The Crown Zellerbach task force determined that a hired scheduling team would be necessary to arbitrate users vying for host access time, intervening occasionally on user monopoly of hosts and allocating time slots for equitable user access across the network.

Another problem was that Atlanta might be scheduled to call into a host session from 7 a.m. to 11 a.m., consequently shut off from remote manufacturing information for the rest of the day. Meanwhile, Crown Zellerbach's response to customers requesting status information would be held up until the following day, creating an information vacuum. Adding to the drawbacks were the dial-up costs — $31/hour for a long-distance connection. When multiplied by the total hours that nodes use the network, 3,080+ hours each month, the telephone charges are considerable.

Despite foreseen problems, the task force agreed that dial-up was the only immediate way to bring the network on-line. There was little question even at the outset that business end results demanded an alternative to dial-up communications, around which every anticipated problem revolved.

The task force launched a search for second-stage communications alternatives that would facilitate a network meeting the following objectives and guidelines:

- **Cost avoidance.** Achieve cost savings over the dial-up circuit network. As a first-time communications network organization, cost containment had to be a paramount parameter guiding all other objectives.
- **Expansion capacity.** Planned expansion had to be accommodated by the existing network without extra capital spending.
- **Utilization of the network by the organization.** User-friendliness and simplicity would have to be supported in order to get the business functions and results for which the network was intended. The goal was to assist business role execution, translating individual productivity boosts

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into overall organizational productivity.

• **Network optimization.** As long as capital concentration had already put a network in place, future communications optimization and modularization would have to be built on the existing network, recycling more benefits and expanding its communications scope to improve return on investment.

With these objectives in mind, communications methods were surveyed for applying improvements to the network's dial-up linkage, yielding four alternatives. The first two alternatives made continued use of dial-up operation.

With dial-up, there were two possible approaches. One would use communicating IBM 5250 Model 12s for every workstation on the network. This would be the only way via dial-up to give the sales representative the ability to connect to whatever destination host he needed. The cost for this advantage, though, would be high: It would entail purchasing terminals for every System/34 and System/38. A sales representative in need of independent host access control would require an individual Model 12, one dedicated to each company location, to be installed at his workstation. Even then, only four sales representatives systemwide could access a particular host at one time.

This approach's demand for the most expensive remote terminals available from IBM would further escalate its cost. It was quickly and decisively dismissed.

The other dial-up approach called for one IBM 5250 Model 12 placed at each sales location. To add extra terminals, less expensive Model 11s could be attached to the communications-controlling Model 12. This approach under dial-up connection, however, missed business objectives.

Under this approach, as soon as one sales representative connects his Model 12 to any remote data base, all other local sales representatives using a Model 11 must follow suit and communicate there. From his Model 12 workstation, one salesman has the flexibility to navigate communications, whereas all other sales workstations at the same location lack any communications control.

With the first approach, access to a System/34 and its data base would be limited to four simultaneous sales users but would exclude all others systemwide. With the second approach, simultaneous access would be limited to four sales offices but would exclude the remainder within the company.

The second, more viable option was a software rather than a hardware solution — Gateway 34/38. Systar Corp. of San Jose, Calif., had just recently developed this communications front-end system that uses IBM's Series/1 to provide access to multiple-host System/34s and 38s from asynchronous terminals and printers.

With this option, it was possible for Crown Zellerbach to realize cost savings in hardware inventory and communications line consolidation and solve the port limitation problem. It enabled Crown Zellerbach to save approximately $4,750 every time an asynchronous terminal was brought online to displace a 5250 terminal.

With communications line consolidation, each terminal requires one communications line connection to a single Gateway 34/38. From it, a terminal can access as many as eight hosts.

This solution relieves Crown Zellerbach's problems because Gateway 34/38 handles the communications for all the terminals and hosts, but only asks for one port from each of the hosts.

As Gateway 34/38 offered the benefit of substantially reducing communications costs by providing a single line access to multiple hosts, it provided the further benefit of flexibility in making the connection: dial-up lines, X.25 public network access or permanent leased-line direct connection.

The one prevailing concern, however, was that because of Crown Zellerbach's high transaction volumes, faster line speeds than the 1,200 bit/sec dial-in service provided by public packet networks were needed to provide adequate response time. But if a network could retain Gateway 34/38's terminal-to-host communications and also take advantage of the high-speed and usage benefits of dedicated leased lines, it would form an answer to Crown Zellerbach's network needs and would be a new kind of network.

Some industry observers immediately challenged the workability of the product development Systar undertook for Crown Zellerbach. Series/1 experience had been limited to the EDX and RPS operating systems. Systar developed a third operating system, its proprietary CMX, for Series/1. Unlike the other two, the Systar CMX is designed expressly for supporting remote terminals in an interactive communications environment.

After a six-month design period, Systar met Crown Zellerbach network prototype specifications and program objectives with a product called Lodestar. A communications front-end modular software set that runs on the Series/1, Lodestar allows the creation of a private company network in a dedicated, high-speed line environment.

Within the context of remote communications, whenever a company network spans four locations, leased lines — not dial-up connections — provide the cost savings advantage. To illustrate, for every line required by dial-up connection to support a sole user, sixty additional users can be supported by a leased line for exactly the same cost.

Substituting leased lines for dial-up also solves several problems and creates advantages for the remote terminal system. It takes advantage of the cluster technique. One 5251 Model 12 terminal is placed at each location, and Model 11s are attached to it or dropped off it in cluster fashion. As the communications controller and dominant contact with System/34s, the Model 12 handles all of a location's communications on behalf of the clustered terminals. This eliminates

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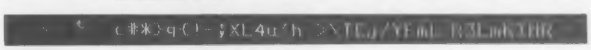

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the need for individual communications lines connected directly between every terminal and every System /34 or System/38 as a cost of establishing communications paths between all points in the work place. In addition to reduced communications line expense, this approach enables the use of less expensive Model 11s instead of procuring Model 12s that are both redundant and more expensive.

While the cluster technique fans out terminal coverage at a particular location, the multipoint capability steps in to extend even more terminal coverage on a single communications line. Point-to-point lines necessitate one-on-one communications lines between every host and terminal. A multipoint line bridges several locations tied together on the same line. It has the ability to transmit System/34 communications to and from one location, cover all the clustered terminals there, then run to other locations. The number of communications lines forming the network is thus reduced, minimizing total network line distance and associated costs.

The fact that this much communications capacity, derived from multipoint leased-line linkage, has been added to the terminal front is insignificant if the four-port limitation is not overcome on the host front as well. This was accomplished by the Series/1, in combination with Systar's Lodestar software, as a global communications processor for the network.

The Series/1 receives all on-line terminal communications transactions and then performs a passthrough to any host requested by a terminal while taking up only one of its ports. Users choose from a display menu listing manufacturing sites, then directly establish sessions with on-site hosts. Because the Series/1 acts as a switching device, users can access one host after another as needed. It is this single connection — the Series/1 — that increases the number of hosts and terminals the Lodestar network can support.

From their remote locations, users maintain and run local data and programs, but they can select and immediately access data and applications maintained on hosts everywhere in the company. More applications, terminals, hosts and users are tied together, melding Crown Zellerbach's decentralized environment into one cohesive information-sharing unit.

In fact, Crown Zellerbach has increased its maximum number of simultaneous users from four to 16, a self-imposed limit to safeguard System/34 performance. And in terms of overall native capacity, Lodestar supports 150 remote devices.

Lodestar's Control Center is located on the operator's console and can be used by a System/34 or System/38 operator. It manages allocation of printers to hosts; monitors line and terminal status; provides message broadcast; aids hardware corrections through vary on/vary off capability; displays statistics on line usage, outages and user connect time; and allows for the network's dynamic reconfiguration without taking down the system. Cost centers, or regional and departmental units concerned with division of costs, find this built-in tracking system instrumental in charge-back accounting. Reports generated from logging statistics often lead to better allocation of communications resources.

From a business standpoint, Lodestar ushered in the capability of integrated operational and communications flow among the three areas that critically support the Crown Zellerbach business function: order entry and billing, inventory control and production planning.

The order entry side of the business captures all information relevant to the production of any customer order. Before the installation, salesmen handwrote orders and facsimiled them to the order entry department of a subject manufacturing plant. This method carried time-consuming disadvantages. Order input and handling at manufacturing sites often stretched backlog to four and five days during peak periods. Manufacturing plants relied on mail for acknowledgment and distribution of orders to sales personnel, which created another time lag. By the time the order entry was confirmed to sales personnel, seven to 10 days had elapsed.

The insertion of corrections caused further delay. The necessity for corrections at either the sales/order or manufacturing/entry end reintroduced a new back-and-forth cycle — facsimile, type the order, mail — tacking on as many as 30 additional days to the order entry cycle.

By sharp contrast, the network operation allows this method: Enter the order and edit on-line through a display screen session taking seven to 10 seconds. The information does not change; just the way it is presented and transacted changes.

The Crown Zellerbach production planning department has gained time-saving advantages as well. Before, the planning department deferred the feasibility of production decision until after an order was typed. Typing and correcting an order superceded planning and order acceptance, a demand made by the forward sequential order of manual entry. Once in the hands of the planning department, an order might be delayed on a planner's desk, hanging production in the balance. And if planning then opted to reject an order, the order entry effort previously made by all departments was wasted.

Now, with the communications network, data input is transferred instantaneously from each sales location to the manufacturing site for universal access and attention by planning and production; it is recorded by the computer as a single transaction and is broadcast to sales and customer representatives as well as all other concerned departments.

Order information is available to production planning without dependence on typing and printing and with a cross-referencing capability. If a production concern arises over an order, a planner directly contacts the issuing salesman, discusses any production bottlenecks and reconciles them — before the order is printed. In other words, the planning function now has precedence over fragmented routing mechanics.

The immediate transfer of the order to planning gives an ongoing snapshot of both current and projected production inventory. Once accepted by planning, orders are automatically entered into an inventory account with lead time recognition, allowing for overall production capacity estimation and accurate planning. No bill of material explosion creeps into planning's sight. Inventory depletion levels are noted on-line, adding another dimension of business control. And an order approved by planning becomes available across the operations stucture for inquiry, update and changes. A process that was formerly prolonged up to a month now has daily turnaround. For planners, order entry has been streamlined into an expedited, organized and controlled planning process.

All of this gives internal business control to Crown Zellerbach's order entry. Inventory control, on the other hand, provides the basis for the firm's customer service. The custom job shop's ability to inquire into a finished goods inventory is the most important aspect to keeping customers. Prior to Lodestar, information was often tracked by Crown Zellerbach personnel on the back of the order form, without procedural control or reliability. Order information was located at remote manufacturing sites by telephone and inside search. Long-distance calls were up; organization productivity was down.

With a communications network, information location is directly on-line. A customer service representative may inquire into production quantity and disposition, shipping delivery and scheduling, finished goods status, bill of lading number, invoice number or even cross-reference from bill of lading number back to the invoice number for any or all of a customer's ordered products. When a customer asks for it, customer service and sales representatives know where the information is and how to obtain it with fast response time.

Network access to that information, moreover, runs on a 24-hour basis, voiding time zone differences among manufacturing site users; work hour differences do not interrupt network availability. And repeated dialing of 10 digits to get through to remote locations no longer slows the user, nor is he subjected to busy signals or wrong-number dialing.

All of this adds up to greatly improved performance for the Crown Zellerbach network user. Sheer convenience has increased volume inquiries by all department units. Within the first month of Lodestar operations, inquiries went above levels projected for the entire first two quarters. This is the result of user acceptance and the discovery of how helpful the network can be on the job.

Pete Kavanaugh, management information systems technical manager of Crown Zellerbach specialty packaging, said, "Everything we did to get this data communications network up and running depended finally on one thing — user's convenience. Users are the engines; without their satisfaction, no amount of technological know-how could pull the organization on these multiprocessing tracks." ■

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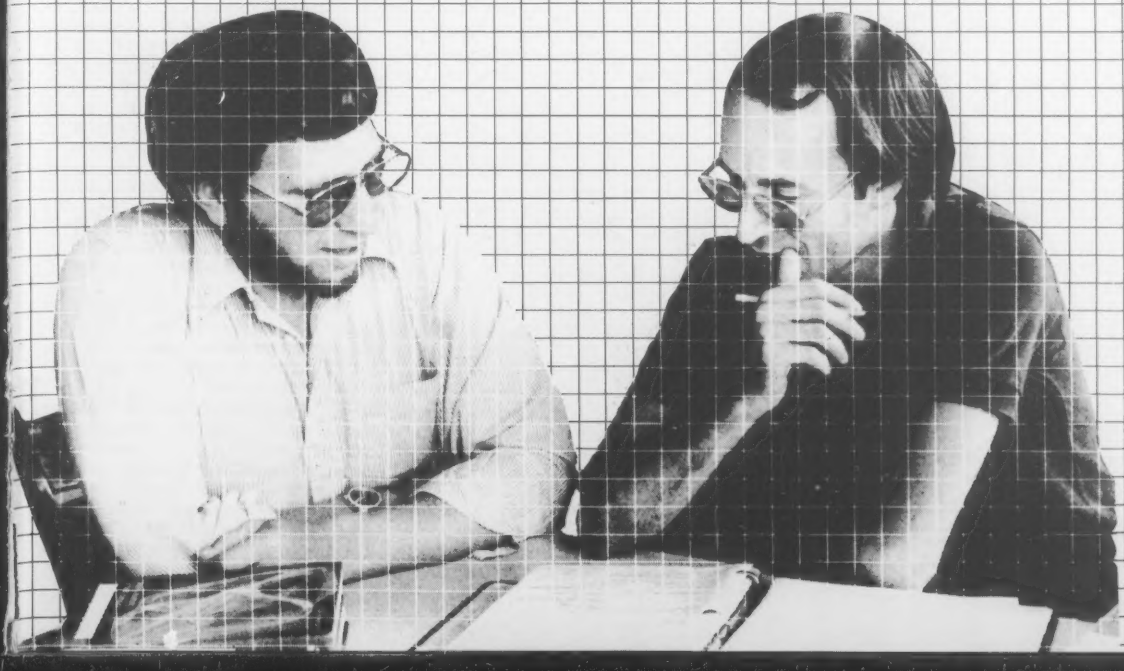
MONITORING NETWORK PERFORMANCE

The tremendous growth in the size, complexity and importance of corporate data communications networks has created a need for network reliability and total data accessibility. Many new tools have been developed to meet these growing requirements for network management. In order to select the correct management tool, communications managers should understand the forces that have driven the current stream of products and the level of sophistication best suited to ▸

BY VAN CHU



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their needs. Because of the rapid pace of technology, network management systems must not only handle information flow, but must also evolve in a way that helps to expand and improve overall networking capability. And as dependence on communications networks increases, top management needs to understand the cost and productivity implications of these assets.

The evolution of network management begins with network control. Every on-line data communications network must have a complete central-site control system. Network control is the key to resolving problems quickly and reliably. With a network control system, a small, centrally located technical staff can routinely monitor the network for faults and remotely activate remedial functions to isolate and bypass problems.

While the bypass function keeps the network operational, personnel can be dispatched to repair the fault and return the system to its normal status. Providing this service without a centrally managed network control system would require a round-the-clock staff of trained technicians at each network site first to troubleshoot and then repair any problems. The cost of this solution would be astronomical and almost impossible to manage.

But centralizing the network control function also requires centralizing all site records. This comprehensive, central-site file should contain all network site information — addresses, terminal type, contract name, dial backup telephone numbers, inventory, operating hours and so on. In addition, information relating to network faults and vendor responses is needed. Keeping these records up-to-date, in order and properly filed and ensuring that they are immediately accessible during fault isolation and repair procedures could require an army of clerks. Furthermore, with paper records, it is almost impossible to provide accurate sets of site data to two or more staff members handling interrelated problems.

The evolution of network management begins with network control. Every network must have a complete central-site control system.

A simple stand-alone data base containing all network site, fault and vendor information can eliminate many of the central-site paper files. Site, vendor and inventory information is entered once. After that, the information is on-line for verification, correction or updating. Two or more people can access and/or correct the information simultaneously with changes available instantly.

A better arrangement is a direct connection between the network control system and the data base. All network configuration changes, automatic test results and fault data are automatically transmitted to the data base and stored there. This automatic data storage and the elimination of errors inherent in operator keying provide a complete and comprehensive data base that accurately represents the network.

Two important data base features — on-line trouble ticket management and administrative data management — streamline central-site operations. For example, a fault report received from the network control system can be used to open quickly a computerized trouble ticket. Once the exact cause and location are determined — either automatically or through remotely controlled troubleshooting — the information is also entered onto the trouble ticket form and will, in turn, trigger the additional display of all pertinent related-site information from the data base. Armed with this information, the operator can initiate a restoral activity simultaneously with the selection and dispatch of service personnel.

Real-time clocks will be started, based on dispatch time or estimated arrival at repair site, and will sound alarms if repair times are exceeded. These alarms help ensure that sites where the repair procedure has not proceeded smoothly will not be lost among other routine trouble tickets. With the trouble ticket stored on-line and displayed on a screen, it is not necessary to pass the single hard-copy trouble ticket among multiple personnel because operators can display a complete and up-to-date copy of all information on their own screens.

When a customer calls about a problem, any trouble ticket operator can respond with current and correct troubleshooting status. Reliable answers will markedly improve user-operator relations. After the problem is solved, the data base will automatically close and store the completed ticket for later review and analysis.

On-line administrative files will eliminate the library of black books containing network site information. The data base can provide the basic blank form that prompts the operator to enter all required data — site address, personnel, equipment configuration, spares — in a complete and consistent manner. Once entered, it is available to all operators simultaneously for on-line displays. This same information is also used by the report generator functions, in which it can be included as either support data to network control reports or as the basis of the report itself (a list of all sites with a particular type of equipment in a specialized configuration).

Even the best run networks experience situations that must be closely monitored. Some state-of-the-art network management systems dedicate a portion of each terminal display to a network status summary. This split-screen feature enables an operator or manager to proceed with other tasks while continuing to monitor the problem. Real-time messages and alerts can be displayed. Important changes can be flagged with visual alarms such as reverse printing or a flashing format. If the summary alarm indicates that a network problem demands more detailed analysis, a complete status report can be requested and displayed with a few keystrokes.

Good data base access features can quickly generate a variety of needed network control reports. A strong report generator package will enable the operator to call out quickly, select and narrow down the display to only pertinent data.

Once this data is displayed, it is possible to evaluate changes quickly and discern trends in the network. Reports highlighting sites with a particularly high fault occurrence, vendors with unusually slow or fast repair responses and sites with consistently poor signal quality will help the network manager control the daily operation of the network.

These reports should be easy to read, displaying sums and averages and calling out any entries that seem out of line. For long reports, page numbers should be added and important subsections should be highlighted with headings that are inserted automatically. Perhaps the most valuable data report feature is the automatic generation of graphs to summarize complex tabular data visually. When dealing with corporate management, a graph can be used quickly and concisely to summarize the network status and, in addition, can be backed up by a complete easy-to-read tabular report.

While automated network control and data base management have many valuable features, some problems still exist — for example, the inability to monitor actual system usage. Today, most network control systems do not access main channel data and, as a result, cannot sense such parameters as CPU wait time, actual transmission errors or average response time. Without this data, the network managers cannot see and experience the system as a user would and must often accept as fact the operator's perception of system response.

The pertinent questions are: What is the length of these delays — minimum, maximum and typical? Are they the same throughout the day, week or month, or is the system usually overloaded at a particular time? Are delays getting longer or shorter? Is the cause of the delays increased system usage or degrading line and equipment quality?

The network manager also needs an overview of current system activity. With only a network control system, the manager cannot track growing system use, lines that are nearing operating capacity or system bottlenecks that could possibly be solved by job rescheduling.

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This lack of main channel data access makes it difficult and expensive to determine the effects of change on network users. Too often, costly mistakes are made based on insufficient data. Just as the company would not develop a product without determining the market potential, a communications network should not be expanded without understanding how efficiently it is being utilized.

The key to monitoring network efficiency is performance measurement. Today, many companies can provide equipment to measure network parameters. Equipment ranging from test boxes to complete systems will provide the needed information. However, such equipment needs careful examination. Purchasing any unit means contending with another vendor. Furthermore, the costs associated with test boxes, the skills required to operate them and the logistics of storage will complicate the already burdensome responsibilties of the network manager. Added to those problems is the need to move the test box physically between various lines and sites in a multipoint, multiline network.

Even if the performance measurement function is offered as a complete stand-alone system with data gathering, management and access, it probably requires separate operator input, separate terminal access, separate hardware and separate reports.

Many manufacturers purchase performance measurement systems from OEMs and patch them into an existing network control system. This linkup tends to be awkward because of the duplicate functions of each portion of the system. Again, the network manager must contend with two separate sets of hardware, software and reports.

It seems that the evolving answer is a truly integrated network control, performance measurement and network management system. In these integrated offerings, specially designed hardware modules individually and independently monitor network sites for network control and performance measurement parameters. These results are stored in a single common data base.

This separation of hardware functions, while transparent to the data communications user and operator, helps ensure that a fault or problem in either function will not affect the other and will not affect actual information flow. Operator control of the system is simple because a dedicated console replaces complex technical jargon with easily understood command functions and verifies and dispatches the system commands entered by the operator.

The single data base enables easy and comprehensive report generation. Data selection and report generation software should facilitate total network reporting capabilities. With one set of commands to access both network control and performance measurement files, the operator or manager can quickly call up all information pertaining to a particular site or problem and perhaps discern a cause-and-effect relationship in the data.

With this insight into the network, both the operator and manager can solve problems before they affect network operations. For the manager, the ability to measure network parameters, such as terminal response time, transaction counts and line utilization, provides an accurate analysis tool for adding equipment, upgrading line speeds and other management decisions.

Since a network changes constantly, it is advantageous to have on-line measuring capabilities for evaluating the system's efficiency. This

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integrated approach allows the manager to optimize network operation by reducing communications costs while still maintaining a responsive system for users. Managers also know about poor response times before users do, and they know exactly what the network control system does in real-time. It is both compatible and cost-effective to integrate these functions.

With the easy availability of an integrated network control and performance measurement data base, the communications manager can:

- Monitor real-time activity to ensure maximum uptime for the user.
- Analyze effects of new applications or system modifications.
- Determine current system utilization and plan for growth.
- Compare levels of user satisfaction with the costs of system upgrades.
- Establish network standards and enforce them.

This information is available through a central-site management console. It places no burden on the network and allows accurate, real-time performance measurement. With this capability and on-line network control and management, the communications manager can satisfy the user's requirements for better service while providing the firm with a cost-effective network.

But even the most comprehensive management system must evolve to handle new and increased demands on communications networks. The ability to expand the system with new remote sites, lines and terminals is of primary importance. In addition, provision must be made to ensure that the central site can handle the increasing number of reports being received without any losses of reporting speed or reliability. Manufacturers often use the key phrases "modular design" and "distributed intelligence" to indicate that a system can expand easily and economically.

Possible new directions for report-generating functions must be considered. These include better and more effective use of color in displays and printed reports. Color can pinpoint problems or highlight unusual situations. Improved graphics capabilities with more style options can help the communications manager select graphs to summarize and present network activity on corporate levels.

The data-handling and selection functions could be improved to produce actual predictive trend reports. This would enable the data base to discern declining parameters and then automatically notify the operator. Another feature, which notes and possibly deletes data that appears to be wrong because it exceeds reasonable parameter ranges by 1,000% and above, could increase report reliability.

As the need for management grows, a complete and up-to-date data base system accessed by a report generator will ensure the continued productivity of users at all levels. The summary data accessible through the network management system must assure executive management that network costs and reliability are contributing to overall corporate profits. For the data communications manager, it must be a tool to monitor network efficiency and plan for controlled growth. And for the day-to-day network operator, new diagnostic and remedial functions must provide continued centralized control for the expanding network.

The varied needs of all users demand a comprehensive, multifaceted system. The importance of the network management system to both the network and corporation as a whole requires a complete and careful analysis of alternatives before the final selection is made. ■

Chu is director, network control products, of Intertel, Inc. in Andover, Mass.

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LOCAL NET LINK PROTOCOLS

In past decades, the only standard in data communications was the physical layer EIA RS-232 standard. Without RS-232, software types would never have wormed their way into the communications field.

Although IBM did a credible job trying to make Binary Synchronous Communications (BSC) a standard link layer protocol, it did not succeed. Burroughs Corp., Sperry Corp., Honeywell, Inc. and all the rest established their own link protocols. In fact, most of the '70s was spent inventing and implementing "better" link protocols. And the present excitement over local network link protocols — Carrier Sense Multiple Access With Collision Detection (CSMA/CD) and token schemes — threatens to consume the early '80s.

In spite of all this, CCITT Recommendation X.25 emerged and has finally taken hold. This recommendation is an interface standard used in accessing a net-▶

By John S. Ambler

work. The recommendation covers three layers of the International Standards Organization (ISO) model of protocol layers: the physical, link and network layers. The X.25 link layer is a full-duplex protocol for establishing links and exchanging blocks. The network layer provides for the establishment of virtual circuits and the exchange of data over these circuits.

The existence of a standard network layer protocol — X.25 Layer 3 — provides opportunities for implementing effective local-area networks and interconnecting these local-area networks via a backbone X.25 packet-switched network.

These opportunities exist because X.25 provides procedures for addressing across a network and across multiple networks.

The existence of a standard network layer protocol — X.25 Layer 3 — provides opportunities for implementing effective local-area networks and interconnecting these local-area networks via a backbone X.25 packet-switched network.

In addition, CCITT Recommendations X.3, X.28 and X.29 define procedures for allowing Ascii asynchronous teletypewriter-like devices to communicate with an X.25 device (data terminal equipment [DTE] or host). The implementation of these recommendations produces a packet assembly/disassembly (PAD) facility. X.28 defines user commands for establishing a virtual circuit and controlling the PAD.

X.3 describes a set of parameters, such as terminal speed and on/off capability, that characterizes each Ascii asynchronous device. X.29 defines a protocol for data exchange between a PAD and an X.25/X.29 host and allows remote control of a PAD from an X.25/X.29 host. Thus, a PAD facility turns an asynchronous terminal into a virtual X.25 device. The PAD maps an asynchronous terminal into an X.25 device.

Use of X.25 and its associated PADs as the access protocol to a local-area network means that the local-area network is an X.25 packet-switched network. By adopting X.25 as the local-area network access protocol, the network architect obtains all the benefits of X.25, including the fact that it is a well-defined standard.

But most importantly, the architect gets a protocol designed for networking. Virtual circuits can be established between devices within one local-area network, between devices on separate local-area networks connected by a backbone packet-switched network or between a local-area network device and a device directly on the backbone packet-switched network.

Furthermore, the PAD concept can be extended. PADs can be implemented for each new non-X.25 device connected to the local-area network. For example, a point-to-point BSC PAD, an IBM 3270 Synchronous Data Link Control PAD and a Honeywell Visual Information Projection (VIP) PAD can be implemented. Each PAD maps the access protocol, such as BSC, into X.25.

If the originating device is BSC and the destination device is VIP, then at the origin, BSC is mapped to X.25. At the destination, X.25 is mapped to VIP. Thus, X.25 is the common protocol. At this time, there are emerging BSC and 3270 PAD standards.

Each device is connected to a local-area network via a bus interface unit. The bus interface unit does two jobs: It acts as the appropriate PAD, and it executes the intra-local-area network protocols. There are normally two layers of intra-local-area network protocol: a media access layer, employing a protocol such as CSMA/CD or token bus, and a link layer, using a protocol such as the IEEE Project 802 link protocol.

If the local-area network uses the X.25 local-area network architecture, then X.25 Level 3 acts as a third intra-local-area network layer. X.25 Level 2 is not used within the local-area network. But the Level 3 X.25 packets, created by the PADs or by X.25 devices themselves, are transmitted within the local-area network.

If a local-area network with complete interoperability is to be provided, then all PADs must be symmetrical. In fact, the PADs must be more than symmetrical. It is not sufficient for an asynchronous TTY PAD to interoperate with another TTY PAD and an X.25 DTE. The TTY PAD must interoperate with the BSC PAD and all other PADs. Not all protocols are created equal, so a one-to-one mapping between PADs is impos-

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sible. But the capabilities of one protocol must be mapped into corresponding capabilities in all other protocols. For example, the on/off flow-control capability of the asynchronous TTY protocol can be mapped into the Wack feature of BSC.

In providing interoperability, flow control and addressing are of critical concern. Flow control is a necessity due to potential speed differences between communications devices, transmission errors at the local-area network exit point or momentary bus interface unit or cable overload situations.

Addressing refers to the mechanism that a local-area network device's protocol uses for specifying the destination of the data it transmits. The asynchronous PAD provides addressing via the X.28 protocol — that is, the user enters a connect command that specifies the destination.

If the local-area network device uses the 3270 BSC protocol, addressing is more difficult. The 3270 control unit and device address can be used, but that does not provide a networkwide unique address. However, the bus interface units can be individually downline loaded with a specific network map. This map can then direct 3270 traffic to the intended device within the local-area network. Thus, access within a subnetwork or community of interest within a local-area network is accomplished with ease.

However, access to 3270 devices outside the user's subnetwork — or access to off-local-area network 3270s — is more difficult. This requires a protocol carried by the 3270 protocol, analogous to X.28, that will identify uniquely the 3270 device to be accessed.

Two networks are interconnected using a unit called a gateway or bridge. The term "gateway" is used to describe the unit if the two networks are dissimilar — that is, if their access protocols are different or if they are entirely different types of networks. For example, if one network is a packet network and the other is a circuit switch, then the networks are entirely different. The term "bridge" is used to define the unit that interconnects two similar networks, such as two X.25 packet networks.

The job of a bridge is much less involved than that of a gateway. A gateway is essentially a PAD between two network protocols: The gateway must be concerned with mapping the protocol of one network to that of the other network. Speed, code and protocol conversion must be accomplished, as well as flow control and addressing.

On the other hand, a bridge between X.25 networks need not be concerned with protocol conversion, flow control and addressing except to a very limited extent. These issues are handled by the X.25 protocol itself, across network boundaries. Flow control to the bridge is needed, but this is handled by the flow-control mechanism within the local-area networks themselves. For example, most local-area networks utilize a bus interface unit-to-bus interface unit and/or a bus interface unit port-to-bus interface unit port flow-control mechanism. The IEEE Project 802 link protocol has a High-Level Data Link Control-type link flow-control mechanism.

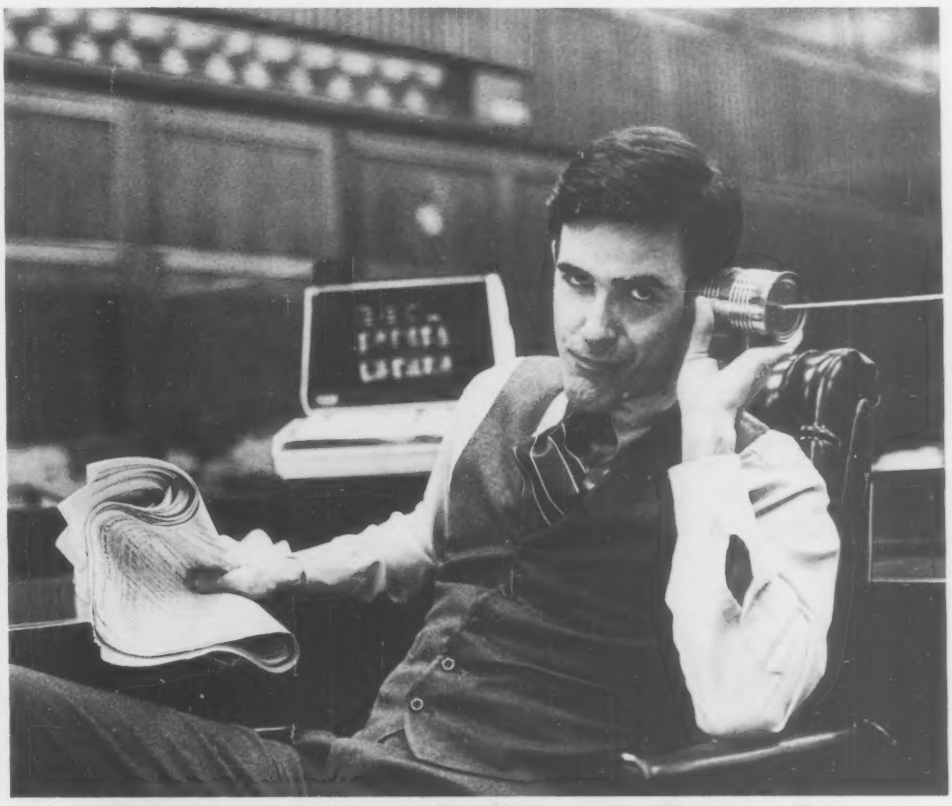
The use of X.25 as the local-area network protocol simplifies the local-area network interconnection problem. It also simplifies the connection to a public or private packet-switching network.

The use of X.25 as the local-area network protocol simplifies the local-area network interconnection problem. It also simplifies the connection to a public or private packet-switching network.

Consequently, one of the most effective architectures for implementing a network of separate local-area networks is the use of X.25 local-area networks connected via an X.25 packet-switching network acting as a backbone network. The packet-switching network allows the X.25 local-area networks to be geographically separated. And the use of X.25 as the networkwide protocol provides networkwide flow control and addressing.

The figure on Page 98 illustrates the interconnection of several X.25 local-area networks via a private X.25 packet-switching network. The private net is then connected to one or more public X.25 networks.

Many organizations currently provide connections between their terminals and hosts and among hosts using an X.25 private



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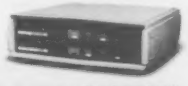

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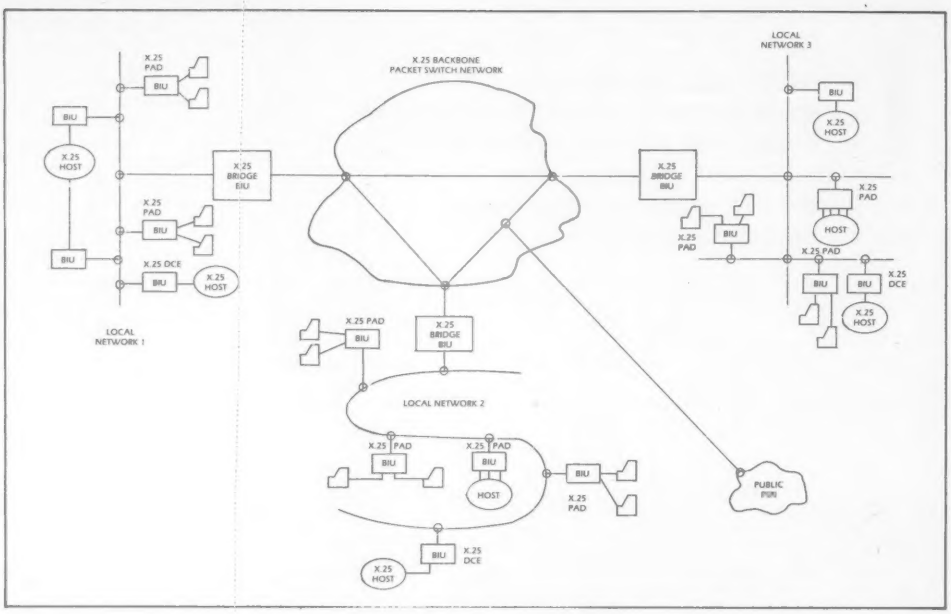

Networking X.25 Local-Area Nets

network. These networks are available from public carriers such as GTE Telenet Communications Corp. and Tymnet, Inc. and from many vendors of custom private packet networks.

These organizations use the private packet-switching network as a backbone network to interconnect dispersed sites. They also use packet-switching network nodes as concentrators. The concentrators act as the connection point to the packet-switching network for all terminals and hosts within an area.

The concentrators present two problems. First, they can create a bottleneck. All traffic within a site must pass through the concentrator. Also, many packet-switching network architectures require that the concentrator forward all traffic to a traffic-switching node in the packet-switching network. This doubles the likelihood of a bottleneck. Second, concentrators are typically expensive. This often results from the fact that they are designed to be fully redundant.

If the concentrators are removed and an X.25 local-area network is substituted, then both drawbacks of the concentrators can be removed. First, the bottleneck is eliminated. Local-area networks are distributed systems; thus, traffic from device X to host Y need not pass through a central switching machine. The traffic flows directly from device X's bus interface unit to host Y's bus interface unit.

Since a large percentage of the traffic originated at one site is also destined for that same site, a distributed network, such as a local-area network, serves to offload the backbone packet-switching network. This reduces response time and provides an architecture that can handle many devices. Second, costs are reduced. This occurs because wiring is reduced and all devices need not be redundantly connected to the local-area network. Further, the incremental cost to expand the number of devices is lower. X.25 can be used as an effective local-area network access protocol. The PAD concept can be used to provide interoperability between dissimilar devices. This approach simplifies the networking of local-area networks and simplifies the connection of local-area networks to public packet-switching networks. ■

Ambler is a director of Contel Information Systems Software and Systems Division in Bethesda, Md.

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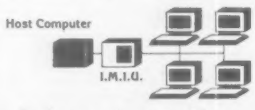

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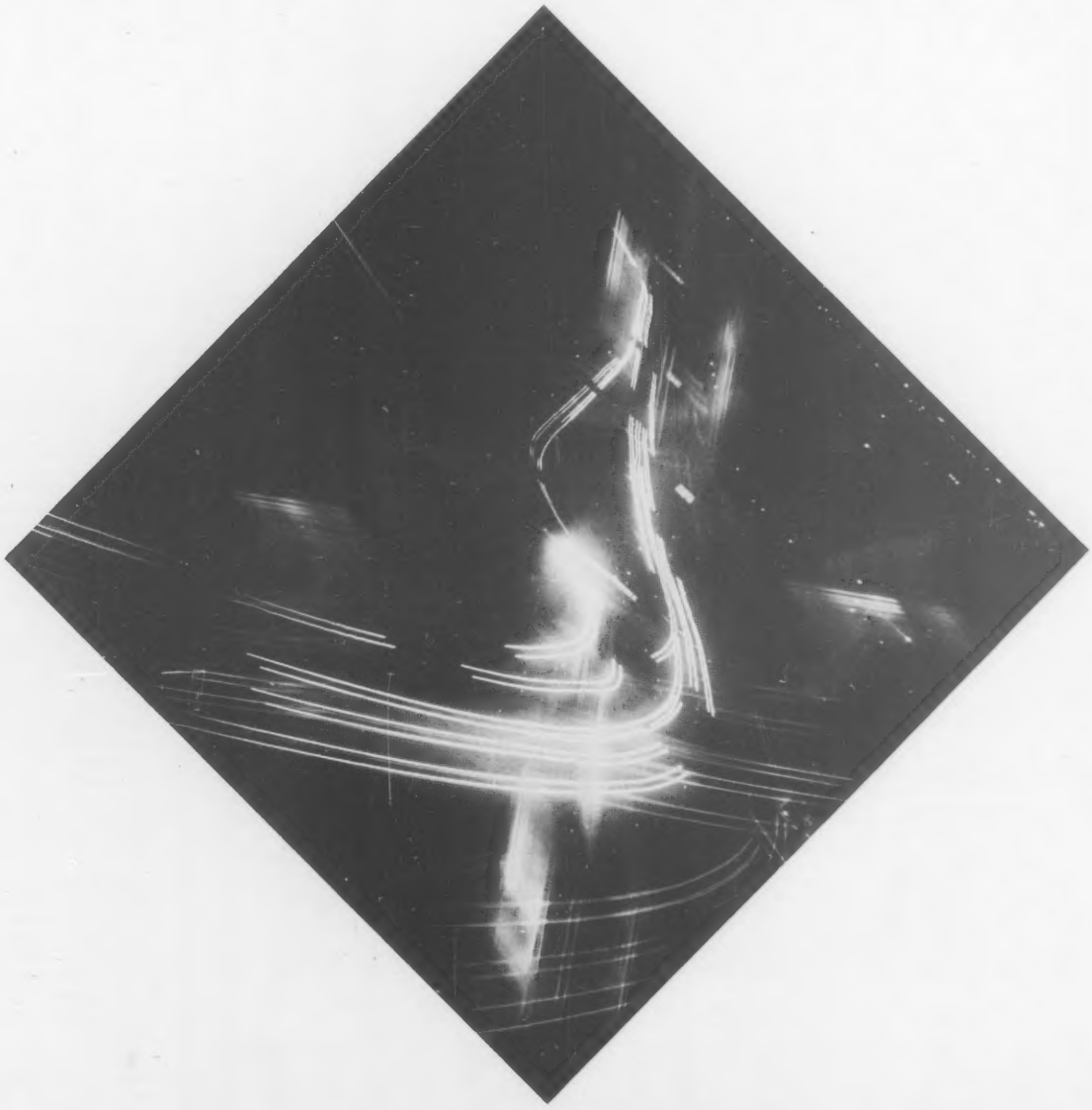
NETWORK MANAGEMENT

The rough-and-tumble world of data communications seems confusing to users: a never-ending New Product of the Month contest, an endless list of vendors and vague, mysterious, ever-changing criteria for purchase.

At the same time, the user is faced with many given situations that he had no part in creating. Most often, the person in charge of data communications inherits an existing network and equipment already in place. This is not a network started from scratch.

The computer manufacturers also offer givens: products based on the capabilities of their equipment and the needs of their customers with architectures and protocols designed to keep customers coming back for more. Carriers also create given situations through their decisions to put together the best transmission facilities for the demanding marketplace. Against this data communications background, the quest for standardization continues.

So the data communications manager planning a network is faced with a long list of givens — existing equipment in place, the products and services of computer and terminal manufacturers and standards that seem to be inevitable. At the same ▶



By William C. Kanupke

time, the hassled manager must sort through the benefits and features of the latest products in data communications to design an optimal network.

The primary concerns for the user evaluating a system or planning a purchase are based on quality manufacturing and advanced design and engineering. However, they are actually quite basic:

- Efficiency. How cost-effective is this equipment, system or service in relationship to its performance?
- Growth. How will this equipment serve the company's requirements now and grow to fill them in the future? (Vertical compatibility.)
- Connectivity. What other products and media will this equipment be required to support? (Horizontal compatibility.)
- Control and management. How can this equipment make a network easy to control and manage?

With the introduction of multiplexing, data communications became an industry of efficiency. Before then, the one-to-one connection from terminal to central processor had served the DP manager well, and the simplest solution was best. However, as the demand for higher speed communications grew, traffic on lines became greater, telephone line charges increased and one-to-one connections were no longer the smartest. At that point, the multiplexer was engineered to increase line efficiency..

To a great extent, multiplexers remain, by definition, a way to make the line more efficient. The main benefit of a multiplexer is that it saves money by reducing line costs even when the initial hardware investment is taken into account. In this respect, the function and importance of the multiplexer has changed little since its introduction. However, many other expectations about multiplexers have changed.

The basic reason for a data communications purchase is efficiency. However, since a network never gets smaller, the growth path for data communications products is another important consideration. No matter how flat the profits of a company or how limited its market potential, managing a growing network is a large part of a data communications manager's job.

The idea of junking a relatively good multiplexer purchased by a predecessor evokes protests from cost-conscious managers. Therefore, today's data communications manager must be certain that the equipment purchased today has a migration path to increased capacity or added features in the future. This is called vertical compatibility.

A classic network situation might start modestly. A four- to eight-channel multiplexer located at a remote location interfaces a number of terminals with a CPU.

As the terminal population increases and covers a greater geographic spread, the user will be able to install a higher volume multiplexer at the first location and move the smaller multiplexer to a less active part of the network. As the network continues to grow, network concentrators can be introduced at this site and the smaller capacity units may be moved out to lower traffic remote locations.

The data communications manager must be knowledgeable about a wide range of products to ensure that he builds the compatibility that provides opportunity for growth. Alternatively, the manager must seek out a single-source vendor that offers a line of "products to grow on."

Efficiency and opportunity for network growth are self-evident product features. The issue of connectivity, however, involves a more complex relationship in a marriage of the equipment within the network.

Connectivity encompasses many areas. Equipment should be able to interface with many devices, so being able to handle all protocols and speeds is essential. Furthermore, several connectivity options increase the efficiency

"Hyatt was a pioneer of local area networks. When Datapoint introduced the first one, we ordered."

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No matter how far an ARC system is expanded, all the users can have access to all the data except where security precautions are installed. So even though more and more people are using more and more computers, there's never a need to duplicate files.

"At present, Hyatt operates forty-five ARC systems," Regan says. "Others are in the planning stages right now. On the operations side we use them for accounting, reservations, and group sales. At Corporate we use them for accounting and for systems development. Obviously, we depend on them heavily. They're like the meters where we check our own financial performance. They simply have to work. And they do.

"Hyatt has stayed with the ARC system because it's been cost-effective. That's the bottom line. I can recommend a certain system to a hotel, but in the end, the system has to sell itself. And keep selling itself after it's installed. Our Datapoint ARC systems have done that."

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- Future trends
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THE CONFERENCE PROGRAM

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I. For Executives in large corporations who are involved in using micros in distributed data processing or as standalone executive workstations, the EMCE conference program includes:

- *Keynote: Increasing Corporate Productivity via the Personal Computer* — (Thurs.)
- *The Executive/Professional Workstation* — (Thurs.)
- *DDP with Microcomputers* — (Thurs.)
- *The Information Resource Center* — (Friday)
- *The Role of Apple and IBM in Corporate Computing* — (Friday)
- *New Issues of Confidentiality and Security in Organizational Information Processing* — (Friday)
- *Personal Computer Acquisition and Implementation Strategies* — (Friday)
- *Compatible Systems and Software for the IBM PC* — (Friday)

II. For Executives who are concerned with the selection and use of microcomputers **primarily in smaller businesses,** the EMCE conference highlights:

- *Keynote: The Personal Computer: The Mouse that Roared!* — (Thurs.)
- *How to Buy a Personal Computer* — (Thurs.)
- *Spread Sheet/Financial Applications* — (Thurs.)
- *New and Future Trends in Personal Computing* — (Thurs.)
- *Word Processing Packages for Personal Computers* — (Friday)
- *DBMS on Personal Computers* — (Friday)
- *A Look at Integrated Software Packages* — (Friday)
- *Panel: Executive Personal Computer Success* — (Friday)

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- *Delivering Good Maintenance, Service & Support* — (Friday)
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For Educators and Administrators, EMCE will hold a special seminar on Saturday, June 25th entitled ***Microcomputers in Education*** which includes the following sessions designed to suit the unique needs of education:

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2. *$5.00 discount* on admission price at the door.

Register for EMCE now! The Sheraton Centre in New York City is the place; June 23-25, 1983 are the dates. Exposition hours: 11-7, Thursday and Friday; 10-6, Saturday. For more information on the conference and exposition, dial 1-800-225-4698 (In Massachusetts, 617-879-0700) and ask for Louise Myerow.

FREE SATURDAY FEATURE SESSIONS FOR ALL ATTENDEES

FREE Special Feature Sessions for exhibit and conference attendees will be held Saturday, June 25 from 9:00-1:00 p.m. The sessions will focus on professional applications for micros and starting your own home based business or office, and will also discuss the personal computers impact on family life, kids and recreation.

SPECIAL HANDS-ON WORKSHOP

In addition to the main conference program, EMCE will offer a two-day **Executive Microcomputer Workshop** for those professionals who wish to get hands-on experience with an Apple or IBM Personal Computer. The workshop will focus on four specific applications: spreadsheet analysis using VISICALC, data base management using dBase II, graphics and communications. An in-class network will be set-up to demonstrate the communications capabilities of personal computers. The two-day seminar will run concurrently with the EMCE Conference Program and will include admission to the exhibits and special feature sessions on Saturday, June 25. **The Executive Microcomputer Workshop** will be sponsored by the Personal Computer Learning Center of New York City and will be held at the Center, located at 1120 Avenue of the Americas, on Thursday and Friday June 23 & 24. **Enrollment is limited,** so please register early with your choice of hands-on using either an Apple or an IBM PC.

EMCE — Sheraton Centre, New York City
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  - ☐ Thursday
  - ☐ Friday
  - ☐ Saturday

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of the network. Switching allows an asynchronous terminal to switch from one CPU port to another, reducing the need for a second terminal connected to the second CPU. Contention allows multiple terminals to request access to one or more CPU front-end processor ports so that every terminal does not need a CPU port. Equipment should also be able to interface with public network offerings, accommodate for an X.25 interface at a reasonable cost and access T-1 facilities.

The most significant aspect of connectivity for the near future will be a high-speed interface between global and local networks, providing the asynchronous user with a path through the entire network at a single location.

Control and management functions set some multiplexers apart in the second generation of multiplexing. The introduction of complex networks made possible with statistical multiplexers enables greater efficiency when user demands are great. However, complex networks also put a greater burden on the equipment to signal and prevent network failure.

Network monitoring is common: Even modems have blinking lights to indicate the status of the line. In more sophisticated equipment, event monitoring is the key to the monitoring process; the unit's console informs the system operator of all special or abnormal occurrences. These event reports may be reported as they occur or displayed on request. Reports contain a description of the nature of the event, a line error or a buffer overflow and information about the device involved, time and date of the occurrence.

At regular intervals, system statistics — average data rate and maximum rates during the preceding interval and buffer utilization — are reported.

Along with these monitoring capabilities, each network has a control center with systems status indicators and the ability to initiate loop-back tests to track down problems within the network, often in time to forestall them.

However, monitoring and conventional control is not enough today because of the size and complexity of modern networks. Human intervention may not be fast or accurate enough to prevent network failure, and users must often rely on automated management features to initiate disaster prevention measures.

When an error is detected, the network concentrator notes it in buffer storage. The number of errors over a specified period of time can trigger three responses. Ratios of errors per time period will vary, of course, according to different network environments. For example, fifty errors in a five-minute period could signal an alert that requires the attention of an operator in the near future. At 75 errors per five-minute period, an alarm could sound, calling for immediate attention. At a higher rate, the network concentrator would intervene directly and put alternate data routing paths into effect.

How does the network manager determine these ratios? Additional management functions are built into the concentrator. Through analysis of error rates, threshold levels are established in the network's historical files for various levels of intervention.

At the same time, if buffer utilization as a measure of error rate is very low, two network paths that are not used very much could be combined. Conversely, high buffer utilization may indicate that additional link capacity is needed to reduce the burden of buffered data.

The objective for all data communications equipment is to economize on data communications costs. However, plans for future multiplexers are more ambitious than just efficient. This data communications equipment will enable design and network management to become the most important function to the data communications manager, rather than monitoring and reacting. ■

Kanupke is director of marketing for Infotron Systems Corp. in Cherry Hill, N.J.

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